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Board 121: Using Tutor-led Support to Enhance Engineering Student Writing for All

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Using Tutor-led Support to Enhance Engineering Student Writing for All

Abstract

Writing Assignment Tutor Training in STEM (WATTS) is part of a three-year NSF IUSE grant with participants at three institutions. This research project seeks to determine to what extent students in the WATTS project show greater writing improvement than students using writing tutors not trained in WATTS. The team collected baseline, control, and experimental data. Baseline data included reports written by engineering and engineering technology students with no intervention to determine if there were variations in written communication related to student demographics and institutions. Control data included reports written by students who visited tutors with no WATTS training, and experimental data included reports written by students who visited tutors who were WATTS-trained. Reports were evaluated by the research team using a slightly modified version of the American Association of Colleges and Universities (AAC&U) Written Communication VALUE Rubric. Baseline data assessment also provided an opportunity to test the effectiveness of the rubric. This paper presents findings from the analysis of the control and experimental data to determine the impact of WATTS on student writing in lab reports. An aggregate score for each lab report was determined by averaging the reviewer scores. An analysis was run to determine if there was a statistical difference between pre-tutoring lab report scores from the baseline, control, and experimental rubric scores for each criterion and total scores; there was not a statistically significant difference. The research team ran a Wilcoxon signed-rank test to assess the relationship between control and experimental aggregate rubric scores for each criterion. The preliminary analysis of the control and experimental data shows that the WATTS intervention has a positive, statistically significant impact on written communication skills regardless of the campus student demographics. Since WATTS has been shown to be a low-cost, effective intervention to improve engineering and engineering technology students' written communication skills at these participating campuses, it has potential use for other institutions to positively impact their students' written communication.

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Introduction

Communicating content knowledge effectively in oral and written formats is important for engineering and engineering technology students. Additionally, it is essential for the ABET-accredited programs from which they graduate to ensure that students hone and demonstrate these skills [1]. Anecdotal observations by engineering and engineering technology instructors and prior research have shown that this is not the outcome observed by employers [2]. A strategy is needed to support instructors in assisting their students with honing their writing skills and thus, their written communication products. Given instructors' multiple obligations, such as delivering content, assessing knowledge, and providing feedback, it is also imperative for any intervention or approach to have a small impact on the instructor while still resulting in a high impact on the students [3].

This paper presents the outcomes from the control and experimental phases of the Writing Assignment Tutor Training in STEM (WATTS), a model for improving engineering and engineering technology students' writing. Subsequent sections will offer an overview of other approaches to improve students' written communication skills, provide an overview of WATTS, and present the research methodology, the results, and the impacts of WATTS. The data presented seeks to address the research question:

> To what extent do students in WATTS show greater writing improvement than students using writing tutors not trained in WATTS?

Approaches to Improving STEM Written Communication

Any approach to improving STEM students' written communication needs to be supported by the instructor's belief that improving writing is essential and that their pedagogical practices uphold that belief [4]. Student writing improves when instructors provide examples of what high-quality writing entails and encourages students to apply prior knowledge of sound conventions [5]. Furthermore, student-centered approaches have been observed to be more successful when the student understands the genre conventions [5]. Three student-centered approaches for improving writing include peer-to-peer, collaborative, and scaffolded.

Peer-to-Peer Approaches

One facet of peer-to-peer writing interventions is considering students' academic level and the feedback they can offer their peers. An approach to improving scientific writing sought to determine if student academic year impacted the ability to provide effective peer-to-peer tutoring [6]. Peer-to-peer tutoring did show an improvement in student writing outcomes, regardless of the academic year of the peer. Conversely, researchers analyzing the writing circle model demonstrated that peer-to-peer tutoring resulted in improved written communication that demonstrated higher-level critical thinking outcomes from students further along in their program of study written communication [7]. However, the writing circle approach requires a high level of commitment, time, and money for the training and its continued use. Each approach, regardless of the academic year of the students, had a positive result, with some of the participating students reflecting that the process helped them to become better writers by seeing the work of others [6] [7].

Collaborative Approaches

A collaborative approach that comes from forming a collaborative relationship between STEM instructors and writing center staff can result in improved technical writing for STEM students who visit the writing center [8]. As part of an institutional initiative to create professional learning communities, one group focused on improving STEM student writing by designing a localized, collaborative approach to reflecting on writing pedagogical practices in STEM. They analyzed how an interdisciplinary team of discipline-specific and humanities-based writing specialists can improve pedagogical practices and student outcomes [9]. Another collaborative approach between discipline-specific instructors and traditional writing centers also saw positive results in a technical university to create a reflective practice for a pair of science instructors about their writing. They also discussed how they could support their students' writing within the courses they taught [10]. Collaborative approaches should engage all the stakeholders to ensure effectiveness.

Scaffolded Approaches

Students with limited technical writing experience benefit from using a scaffolded approach to improve lab reports [11] [12]. One method was using templates that started with a fill-in-the-blank format and then progressively provided less supporting text to aid students in understanding what elements they need to include in a well-written, highly technical physics lab report [11]. Though effective, this approach required a high level of effort to implement. The other approach incorporated quick but impactful metacognitive activities in a writing-intensive biology course [12]. Both models were well-received by students, who self-reported that the intended outcome, improved lab report writing, occurred. Assessing the writing objectively through a systemic approach may strengthen scaffolded approaches.

Writing Assignment Tutor Training in STEM

The Writing Assignment Tutor Training in STEM (WATTS) model incorporates several of the elements from the literature. WATTS involves collaboration with the instructor, the writing center supervisor, and the tutors. It is student-focused, requiring students to take their written work to the tutor. The tutoring session incorporates reflective practice and encourages revision.

Project Background

The WATTS model began at Campus A after the instructor became frustrated with the quality of the student lab reports. The instructor collaborated with the writing center director, resulting in a low-cost intervention that varied from traditional approaches to STEM tutoring. Traditional tutoring approaches to discipline-specific, including STEM, writing demonstrated tutors focusing on 'lower-order concerns when higher-order concerns were present' [13, p. 93] and allowed students to assert authority as the content knowledge expert even though the tutor observed higher-order concerns [13]. WATTS, however, applies knowledge transfer practices and a just-in-time training program to target a specific assignment's written communication outcomes [14]. WATTS-trained tutors feel confident in asserting authority in the sessions [15]. The WATTS training session involves the writing center supervisor collaborating with the content course instructor who prepares materials for the session (examples of a quality lab report, a report needing significant improvement, a glossary of terms for the lab, and the lab report requirements). The approach involves the course instructor, writing center supervisor, and tutors participating in a one-hour training session to prepare the tutors for the student visits with the lab reports. Following the session, the students revise the lab report and submit it to the instructor.

After observing improvements in student written communication, additional data collection included information on the peer tutor self-efficacy in tutoring engineering and engineering technology students [14]. The results showed WATTS had a positive impact on tutors, and subsequent research has supported this with statistically significant data demonstrating its positive impact on peer tutor self-efficacy and application of knowledge transfer skills [15]. During this iteration of the research, the student lab reports also had noticeable improvements, and the team received a STEM Education Innovation & Research Institute at IUPUI seed grant to determine if this impact could be replicated at other institutions.

The data supported the idea that WATTS impacts student writing and could be replicated. To assess additional data and obtain a robust data set to measure the impacts of WATTS, the researchers applied for a National Science Foundation Innovations in Undergraduate STEM Education grant. The three-year NSF-funded research at four campuses serves a diverse student population, including traditional, first-generation, Hispanic, ELL, bi-lingual, and adult learners. The four campus writing centers have diverse settings; two are learning centers that serve many disciplines, one is a traditional writing center with generalist tutors, and one is a technical communication writing center.

WATTS Data Collection Process
Data collection included baseline, control, and experimental phases. Additional details are provided in Fig. 1. During the baseline phase, student lab reports were collected from the participating campuses for each course for one assignment to determine the baseline level of writing. The students were not required to visit a peer tutor during this phase. During the control phase, the tutors were not trained using the WATTS method, students were required to visit the writing tutors, and student lab reports were collected pre- and post-tutor visits. During the experimental phase, tutors were trained just prior to the assignment, students were required to visit a WATTS-trained tutor, and student lab reports were collected pre- and post-tutor visits.

Baseline Writing Assessment (No tutor visit)	Control Group (Non-WATTS-trained tutor visit)	Experimental Group (WATTS-trained tutor visit)
• Instructor assigns lab • Students submit lab reports • Research team assesses lab reports	• Instructor assigns lab with required writing tutor visit • Pre-visit lab report drafts are collected • Student participates in tutoring session with non-WATTS-trained tutor • Post-visit lab reports are collected • Research team assesses pre- and post-visit lab report	• Instructor assigns lab with required writing tutor visit • Pre-visit lab report drafts are collected • Student attends tutoring session with WATTS-trained tutor • Post-visit lab reports are collected • Research team assesses pre and post lab reports

Fig. 1 Data Collection and Assessment Process

A reliable, valid rubric was needed to assess the writing in the lab reports, given that this was not the WATTS model’s focus during prior implementation. The American Association of Colleges and Universities (AAC&U) Written Communication VALUE Rubric was selected because of its proven reliability and use in other research in the field of STEM. The AAC&U VALUE rubrics have a body of work that supports their use for assessing written communication student artifacts [16] [17]. In addition, one of the WATTS team members had been trained on the AAC&U VALUE rubric use and calibration. Like other research utilizing the AAC&U VALUE Rubrics, the research team made minor modifications to the instrument [16] [17]. The modifications were to add a 0 for not present or applicable and change “graceful” language to “highly technical” language due to the STEM nature of writing. The modified rubric is provided in Appendix A[18]. The writing in all reports was assessed using this modified rubric. During the baseline phase, the assessment team examined whether variations in writing existed among the student populations at the different locations. No significant variations were identified, confirming that campus location was not a variable for the remaining phases [18]. As presented in Table 1, the five criteria from the rubric show room for growth in those written communication components.

TABLE 1

AAC&U RUBRIC SCORE DESCRIPTIVE STATISTICS FOR BASELINE STUDENT REPORTS

	All Campuses (N = 92)		Campus A (N = 22)		Campus B (N = 19)		Campus C (N =38)		Campus D (N =13)	
Criteria	M	SD	M	SD	M	SD	M	SD	M	SD
Context of and Purpose for Writing	1.65	.767	1.50	.792	1.50	.688	1.84	.767	1.58	.758
Content Development	1.63	.827	1.48	.976	1.45	.686	1.79	.754	1.65	.892
Genre and Disciplinary	1.76	.782	1.64	.780	1.66	.815	1.80	.783	1.96	.720
Sources and Evidence	.41	.620	.11	.321	.13	.343	.51	.663	1.00	.693
Control of Syntax and Mechanics	2.05	.696	2.30	.668	1.89	.689	1.95	.691	2.15	.675

Research Methods

Research has shown that a visit to a writing center shows some improvement in student writing for mechanics and grammar but does not consistently show improvement in content [19]. Initial assignment-specific tutor-training research showed that quality of writing in student lab reports improved, including in the technical content. The most recent WATTS research sought to determine if a single, assignment-specific writing tutor visit would improve the quality of engineering and engineering technology students' written communication at a statistically significant level. Note that the researchers do not propose that one visit with a WATTS-trained tutor will result in a dramatic increase in writing skills; we are seeking to measure the impact of a visit with a WATTS-trained tutor for one assignment.

Methods

As outlined in Fig. 1, during the control and experimental phases, the four campuses collected and de-identified student lab reports pre- and post-tutoring visits and stored them in a secure file accessible by only the research team. The same process used to assess the baseline reports was utilized for the control and experimental reports. The research team divided the reports between two teams of two raters and used the modified AAC&U Written Communication VALUE Rubric to score the pre- and post-tutor visit student lab reports. The research team set a goal that 90% or greater of the rubric-assessed ratings should meet the +/- 1 point of the other rater's score for the control and experimental student lab reports.

The control phase met the 90% threshold for all five criteria during pre- and post-tutor visit scores. The initial experimental data collection phase had three criteria that did not meet the threshold. The pre- and post-tutor visit criteria for Context/Purpose had 88.73% within the +/-1 point, and the post-tutor visit criteria for Sources/Evidence had 88.73% within the threshold. Research teams reviewed the scores outside of the threshold, recalibrated, and made any modifications they deemed necessary. After the modifications, a 90% threshold was reached. The rubric outcomes were analyzed using SPSS v28. The aggregate score for each lab report was determined for the control and experimental phases. The research team ran a Wilcoxon signed-rank test to assess the relationship between control pre- and post-tutor visit student lab reports and experimental pre- and post-tutor visit aggregate rubric scores for each criterion score.

Results

There were 62 pre-tutoring visit and 82 post-tutoring visit student lab reports collected during the control phase from Campuses A, B, and C during Years 1 and 2. Campus D's results were omitted from the control and experimental phase comparisons during Year 2 because the project-participating course is only offered once a year at this campus. Therefore, control and experimental data were collected at different times in the same semester and were not analyzed with the other data.

There were 63 pre- and post-tutoring visit experimental phase student lab reports collected from Campuses A, B, and C during Years 2 and 3. Appendix B, Tables 2-6, provide the rubric scores for each criterion of the rubric for each campus and the totals for Campuses A, B, and C. Results for Campus D are provided in Appendix C, Table 7.

A Wilcoxon signed-rank test revealed that student lab reports assessed for improvement for the criterion *Context of and Purpose for Writing* were statistically significant after visiting with a non-WATTS-trained tutor (*Md =1.5, n= 62*) compared to before visiting with a non-WATTS-trained tutor (*Md -= 1.5, n = 82*), $z = -4.614$, $p \leq 0.01$. A Wilcoxon signed-rank test revealed that student lab reports assessed for improvement for the criterion *Context of and Purpose for Writing* were statistically significant after visiting with a WATTS-trained tutor (*Md =1.50, n= 63*) compared to before visiting with a WATTS-trained tutor (*Md -= 2.00, n = 63*), $z = -4.466$, $p \leq 0.001$. Appendix B, Table 2 includes additional detail with rubric score distribution.

A Wilcoxon signed-rank test revealed that student lab reports assessed for improvement for the criterion *Content Development* were statistically significant after visiting with a non-WATTS-trained tutor (*Md =1.50, n= 62*) compared to before visiting with a non-WATTS-trained tutor (*Md -= 1.50, n = 82*), $z = -3.076$, $p \leq 0.01$. A Wilcoxon signed-rank test revealed that student lab reports assessed for improvement for the criterion *Content Development* were statistically significant after visiting with a WATTS-trained tutor (*Md =1.50, n= 63*) compared to before visiting with a WATTS-trained tutor (*Md -= 2.50, n = 63*), $z = -5.606$, $p \leq 0.001$. Appendix B, Table 3 includes additional detail with rubric score distribution.

A Wilcoxon signed-rank test revealed that student lab reports assessed for improvement for the criterion *Genre & Disciplinary Conventions* were statistically significant after visiting with a non-WATTS-trained tutor (*Md =1.25, n= 62*) compared to before visiting with a non-WATTS-trained tutor (*Md -= 1.50, n = 82*), $z = -2.704$, $p \leq 0.01$. A Wilcoxon signed-rank test revealed that student lab reports assessed for improvement for the criterion *Genre & Disciplinary Conventions* were statistically significant after visiting with a WATTS-trained tutor (*Md =1.50,* *n*= *63*) compared to before visiting with a WATTS-trained tutor (*Md -= 2.00, n = 63*), *z* = -4.506, $p \leq 0.001$. Appendix B, Table 4 includes additional detail with rubric score distribution.

A Wilcoxon signed-rank test revealed that student lab reports assessed for improvement for the criterion *Sources and Evidence* were statistically significant after visiting with a non-WATTS-trained tutor (*Md =.00, n= 62*) compared to before visiting with a non-WATTS-trained tutor (*Md -= .00, n = 82*), *z* = -2.183, $p \leq 0.05$. A Wilcoxon signed-rank test revealed that student lab reports assessed for improvement for the criterion *Sources and Evidence* were statistically significant after visiting with a WATTS-trained tutor (*Md =.00, n= 63*) compared to before visiting with a WATTS-trained tutor (*Md -= 1.00, n = 63*), *z* = -4.065, $p \leq 0.001$. Appendix B, Table 5 includes additional detail with rubric score distribution.

A Wilcoxon signed-rank test revealed that student lab reports assessed for improvement for the criterion *Control of Syntax and Mechanics* were statistically significant after visiting with a non-WATTS-trained tutor (*Md =2.00, n= 62*) compared to before visiting with a non-WATTS-trained tutor (*Md -= 2.00, n = 82*), *z* = -2.290, $p \leq 0.05$. A Wilcoxon signed-rank test revealed that student lab reports assessed for improvement for the criterion *Control of Syntax and Mechanics* were statistically significant after visiting with a WATTS-trained tutor (*Md =2.00, n= 63*) compared to before visiting with a WATTS-trained tutor (*Md -= 2.50, n = 63*), *z* = -5.048, $p \leq 0.001$. Appendix B, Table 6 includes additional detail with rubric score distribution.

Analysis

The results support the use of WATTS to improve the quality of engineering and engineering technology students' written communication at a statistically significant level.

When analyzing the control phase, a visit with the non-WATTS-trained tutor demonstrated an improvement in the student's lab reports. This impact aligns with prior research in engineering students visiting the writing center. Visiting a generalist tutor has been shown to positively impact syntax and mechanics since their feedback is primarily about areas the tutor was more confident about, such as grammar, format, and citations [19].

A visit to the WATTS-trained tutor during the experimental phase showed a higher statistical significance for all five modified AAC&U Written Communication VALUE Rubric criteria. Looking at the individual campuses, students that attended a tutoring session with a WATTS-trained tutor submitted lab reports that showed a statistically significant improvement for all five criteria at Campuses A and C. Students from Campus B did not show statistical significance for any of the criteria. We attributed this to a variety of reasons outside the variables in consideration for this study. Despite this issue, when analyzing the three campuses the improvements in the student lab reports were statistically significant at $p \leq 0.001$ for all criteria.

Like the writing circles model's statistically significant improvement in students' writing [7], the WATTS model demonstrates an impact in improvement for students' writing. In contrast, the writing circles model involves a substantial level of time for training and implementation, both for the instructors and students. The WATTS model provides a low-cost, just-in-time approach with a positive impact. Similar to the other intervention models discussed in the literature, the

WATTS model possesses many of the desired traits including ease of implementation for the instructors and being student-focused. Though outside the scope of this paper, the quantitative and qualitative data that has been gathered by the researchers also supports instructor belief of WATTS' ease of implementation and observed benefit to the students.

Conclusions, Limitations, and Future Work

Effective written communication skills are an essential attribute that graduates from engineering and engineering technology programs need to possess. The objective of this paper was to present data and the outcomes to assess to what extent a visit to a WATTS-trained tutor affects the students' written lab reports compared to a non-WATTS-trained tutoring visit. Analysis of the baseline student lab reports demonstrated that the institution location and student demographics did not influence the engineering and engineering technology students' written communication outcomes. Based on the results and analysis of the control and experimental data, a visit with a WATTS-trained tutor positively impacts the engineering and engineering technology student's written communication for each assessed AAC&U criterion for the institutions.

Additional experimental data continues to be collected and assessed at all three institutions to measure WATTS' impact. One limitation of the data presented is that the impacts are being measured for one assignment for each course for each campus. This offers an opportunity for future research to determine if the impacts are transferable to other assignments within these courses and for courses outside as well. Additional options for further research include assessing the WATTS model in writing-intensive courses in one or more STEM areas.

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Appendix A

The research team made two modifications to the original AAC&U rubric. One modification was to change the Control of Syntax and Mechanics criteria for Capstone 4. The substitution "highly technical language that skillfully communicates" was made in place of "uses graceful language that skillfully communicates meaning to readers with clarity and fluency and is virtually error-free." The original rubric had four levels: Capstone (4), two levels of Milestones (3 and 2), and Benchmark (1). Additionally, the research team added the level Not Present or Demonstrated (0). See Table 2 for the full explanation of the criteria for each level.

TABLE 2

MODIFIED AAC&U WRITTEN COMMUNICATION VALUE RUBRIC

Criteria	0	1	2	3	4
Context of and Purpose for Writing	Not present or demonstrated.	Demonstrates minimal attention to context, audience, purpose, and to the assigned tasks(s) (e.g., expectation of instructor or self as audience).	Demonstrates awareness of context, audience, purpose, and to the assigned tasks(s) (e.g., begins to show awareness of audience's perceptions and assumptions).	Demonstrates adequate consideration of context, audience, and purpose and a clear focus on the assigned task(s) (e.g., the task aligns with audience, purpose, and context).	Demonstrates a thorough understanding of context, audience, and purpose that is responsive to the assigned task(s) and focuses on all elements of the work.
Content Development	Not present or demonstrated.	Uses appropriate and relevant content to develop simple ideas in some parts of the work.	Uses appropriate and relevant content to develop and explore ideas through most of the work.	Uses appropriate, relevant, and compelling content to explore ideas within the context of the discipline and shape the whole work.	Uses appropriate, relevant, and compelling content to illustrate mastery of the subject, conveying the writer's understanding, and shaping the whole work.
Genre and Disciplinary Conventions	Not present or demonstrated.	Attempts to use a consistent system for basic organization and presentation.	Follows expectations appropriate to a specific discipline and/or writing task(s) for basic organization, content, and presentation.	Demonstrates consistent use of important conventions particular to a specific discipline and/or writing task(s), including organization, content, & presentation, and stylistic choices.	Demonstrates detailed attention to and successful execution of a wide range of conventions particular to a specific discipline and/or writing task(s) including organization, content, presentation, formatting, and stylistic choices.
Sources and Evidence	Not present or demonstrated.	Demonstrates an attempt to use sources to support ideas in the writing.	Demonstrates an attempt to use credible and/or relevant sources to support ideas that are appropriate for the discipline and genre of the writing.	Demonstrates consistent use of credible, relevant sources to support ideas that are situated within the discipline and genre of the writing.	Demonstrates skillful use of high-quality, credible, relevant sources to develop ideas that are appropriate for the discipline and genre of the writing.
Control of Syntax and Mechanics	Not present or demonstrated.	Uses language that sometimes impedes meaning because of errors in usage.	Uses language that generally conveys meaning to readers with clarity, although writing may include some errors (four or more but do not impede meaning).	Uses straightforward language that generally conveys meaning to readers. The language in the document has few errors (three or less).	Uses highly technical language that skillfully communicates meaning to readers with clarity and fluency and is virtually error-free.

Appendix B

Tables 2-6 provide the aggregate rubric score distribution for the control and experimental phase student lab reports assessment.

TABLE 3

AAC&U RUBRIC DATA: CONTEXT AND PURPOSE FOR WRITING

	Campus A				Campus B				Campus C				Campuses A, B, and C			
	Control*		Experimental***		Control**		Experimental		Control**		Experimental*		Control***		Experimental***	
Rubric Score	Pre (N=14)	Post (N=17)	Pre (N=29)	Post (N=29)	Pre (N=23)	Post (N=37)	Pre (N=9)	Post (N=9)	Pre (N=25)	Post (N=28)	Pre (N=25)	Post (N=25)	Pre (N=62)	Post (N=82)	Pre (N=63)	Post (N=63)
0															0	0
0.5	1				1	1							2	1	0	0
1	4	4	8	5	14	8	1	1	5	5			23	17	9	6
1.5	8	9	17	8	6	20	3	3	9	7	6	4	23	36	26	15
2	1	3	4	10	2	3	5	4	8	8	6	4	11	14	15	18
2.5		1		6		5		1	2	7	12	14	2	13	12	21
3										1	1	3		1	1	3
3.5									1				1		0	0
4															0	0

* $p \leq 0.05$. ** $p \leq 0.01$. *** $p \leq 0.001$

TABLE 4

AAC&U RUBRIC DATA: CONTENT DEVELOPMENT

	Campus A				Campus B				Campus C				Campus A, B, and C			
	Control		Experimental***		Control		Experimental		Control**		Experimental**		Control**		Experimental***	
Rubric Score	Pre (N=14)	Post (N=17)	Pre (N=29)	Post (N=29)	Pre (N=23)	Post (N=37)	Pre (N=9)	Post (N=9)	Pre (N=25)	Post (N=28)	Pre (N=25)	Post (N=25)	Pre (N=62)	Post (N=82)	Pre (N=63)	Post (N=63)
0	1												1		0	0
0.5	1	1			1	2							2	3	0	0
1	3	5	10	3	13	16	3	1	8	6	2		24	27	15	4
1.5	5	4	13	6	8	12	3	3	8	8	6	3	21	24	22	12
2	4	7	6	7	1	4	3	5	6	7	5	3	11	18	14	15
2.5				11		2			3	6	11	14	3	8	11	25
3				2						1	1	5		1	1	7
3.5															0	0
4															0	0

* $p \leq 0.05$. ** $p \leq 0.01$. *** $p \leq 0.001$

TABLE 5

AAC&U RUBRIC DATA: GENRE & DISCIPLINARY CONVENTIONS

	Campus A				Campus B				Campus C				Campuses A, B, and C			
	Control		Experimental***		Control		Experimental		Control*		Experimental*		Control**		Experimental***	
Rubric Score	Pre (N=14)	Post (N=17)	Pre (N=29)	Post (N=29)	Pre (N=23)	Post (N=37)	Pre (N=9)	Post (N=9)	Pre (N=25)	Post (N=28)	Pre (N=25)	Post (N=25)	Pre (N=62)	Post (N=82)	Pre (N=63)	Post (N=63)
0															0	0
0.5						1			1				1	1	0	0
1	4	6	6	1	14	15	2	2	12	10	2	1	30	31	10	4
1.5	4	2	13	6	8	14	4	3	7	8	12	9	19	24	29	18
2	4	6	9	10	1	2	3	4	3	6	5	3	8	14	17	17
2.5	2	2	1	12		4			1	3	5	10	3	9	6	22
3		1							1	1	1	2	1	2	1	2
3.5															0	0
4															0	0

* $p \leq 0.05$. ** $p \leq 0.01$. *** $p \leq 0.001$

TABLE 6

AAC&U RUBRIC DATA: SOURCES AND EVIDENCE

	Campus A				Campus B				Campus C				Campuses A, B, and C			
	Control***		Experimental***		Control		Experimental		Control		Experimental*		Control*		Experimental***	
Rubric Score	Pre (N=14)	Post (N=17)	Pre (N=29)	Post (N=29)	Pre (N=23)	Post (N=37)	Pre (N=9)	Post (N=9)	Pre (N=25)	Post (N=28)	Pre (N=25)	Post (N=25)	Pre (N=62)	Post (N=82)	Pre (N=63)	Post (N=63)
0	12	13	20	14	20	29	9	8	5	2	3	1	37	44	32	23
0.5	1	2	3		1	3					1		2	5	4	0
1		1	4	6	1	2		1	11	17	5	5	12	20	9	12
1.5	1	1	2	7	1	1			4	5	8	7	6	7	10	14
2				1		1			4	2	6	8	4	3	6	9
2.5				1					1	2	2	4	1	2	2	5
3													0	0	0	0
3.5													0	0	0	0
4													0	0	0	0

$* p \leq 0.05$. $** p \leq 0.01$. $*** p \leq 0.001$

TABLE 7

AAC&U RUBRIC DATA: CONTROL OF SYNTAX AND MECHANICS

	Campus A				Campus B				Campus C				Campuses A, B, and C			
	Control		Experimental***		Control		Experimental		Control		Experimental**		Control*		Experimental***	
Rubric Score	Pre (N=14)	Post (N=17)	Pre (N=29)	Post (N=29)	Pre (N=23)	Post (N=37)	Pre (N=9)	Post (N=9)	Pre (N=25)	Post (N=28)	Pre (N=25)	Post (N=25)	Pre (N=62)	Post (N=82)	Pre (N=63)	Post (N=63)
0						1								1	0	0
0.5						1				1				2	0	0
1		1			5	17			4				9	18	0	0
1.5	3	3	4		8	2	1	1	9	7	4	1	20	12	9	2
2	2	4	16	9	1	12	5	4	8	13	11	12	11	29	32	25
2.5	6	3	9	16	8	3	3	4	3	5	8	6	17	11	20	26
3	3	6		4	1				1	2	2	6	5	8	2	10
3.5															0	0
4															0	0

* $p \leq 0.05$. ** $p \leq 0.01$. *** $p \leq 0.001$

Appendix C

Table 7 provides the aggregate rubric score distribution for the control and experimental phase student lab reports assessment for Campus D.

TABLE 8

AAC&U RUBRIC DATA: CAMPUS D CONTROL AND EXPERIMENTAL SCORES

Control										
	Context of and Purpose for Writing**		Content Development		Genre and Disciplinary Conventions		Sources and Evidence		Control of Syntax and Mechanics	
Rubric Score	Pre (N=10)	Post (N=12)	Pre (N=10)	Post (N=12)	Pre (N=10)	Post (N=12)	Pre (N=10)	Post (N=12)	Pre (N=10)	Post (N=12)
0							1	2		
0.5										
1	4	3	2	3	1	3	5	3		
1.5	3	2	5	4	5	3	3	6	4	3
2	3	5	3	4	3	3	1		5	4
2.5		1		1	1	2		1		1
3		1				1			1	4
Experimental										
	Context of and Purpose for Writing		Content Development*		Genre and Disciplinary Conventions		Sources and Evidence		Control of Syntax and Mechanics*	
Rubric Score	Pre (N=8)	Post (N=8)	Pre (N=8)	Post (N=8)	Pre (N=8)	Post (N=8)	Pre (N=8)	Post (N=8)	Pre (N=8)	Post (N=8)
0							2	2		
0.5							1			
1							2	2		
1.5	5	4	6	1	1		3	4	2	
2	3	2	2	4	7	6			2	2
2.5		2		3		2			4	6
3										

* $p \leq 0.05$. * $p \leq 0.01$. *** $p \leq 0.001$