Board 317: Improving Undergraduate STEM Writing: A Collaboration Between Instructors and Writing Center Directors to Improve Peer-Writing Tutor Feedback

Dr. Robert Weissbach, Indiana University - Purdue University, Indianapolis

Robert Weissbach is currently chair of the department of engineering technology at IUPUI. From 1998 - 2016 he was with Penn State Behrend as a faculty member in Electrical and Computer Engineering Technology. His research interests are in renewable energy, energy storage, and engineering education.

Ms. Ruth Camille Pflueger, Pennsylvania State University, Behrend

Ruth Pflueger has been the director of the Learning Resource Center at Penn State Behrend for 20 years, where she is also an affiliate instructor of English. She has been involved in a number of federal grants, including two NSF STEM grants, an EU-Atlant

Dr. Immanuel Edinbarough, P.E., The University of Texas, Rio Grande Valley

Immanuel A. Edinbarough received his B.Sc. (Applied Sciences) degree from PSG College of Technology, University of Madras, India, his B.E.. (M.E.) degree from the Institution of Engineers, India, M.E. (Production Engineering) degree from PSG College of Te

Dr. Corinne C. Renguette, Indiana University - Purdue University, Indianapolis

Corinne Renguette, Ph.D., is Associate Professor of Technical Communication, Chair of the Department of Technology Leadership and Communication, and Director of the Technical Communication Writing Center in the Purdue School of Engineering and Technology at IUPUI. She is co-coordinator of the Diversity Equity and Inclusion track of the Assessment Institute and her research focuses on inclusion in STEM education, communication in STEM education, user-centered design and user experience (UX), and the assessment of educational materials.

Dr. Brandon Sorge, Indiana University - Purdue University, Indianapolis

Brandon Sorge is an Associate Professor of STEM Education Research in the Department of Technology Leadership and Communication at the Purdue School of Engineering and Technology at IUPUI. His research interests include all aspects of STEM education, espe

Dr. Gamini P. Mendis, Pennsylvania State University, Behrend
Matthew Rothrock
Annwesa Dasgupta
Johanna Bodenhamer, IUPUI

Graduate Research Assistant

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Abstract

Undergraduate writing skills in STEM fields, especially engineering, need improvement. Yet students in engineering fields often do not value them and underestimate the amount of writing they will do in their careers. University writing centers can be a helpful resource, but the peer writing tutors that often staff them need to be prepared for the differences in writing between humanities and STEM fields. The Writing Assignment Tutor Training in STEM (WATTS) model was designed to improve tutor confidence and student writing. In this innovative training, the writing center supervisor and STEM instructor collaboratively create a one-hour training for tutors about the assignment content, technical terminology, genre conventions, and instructor expectations.

A research study on this multidisciplinary collaborative project is being conducted to determine the impact of WATTS on students, tutors, and faculty and to identify its mitigating and moderating effects, assessing the elements of the model that have the most impact. Data from all WATTS stakeholders—students, tutors, faculty and writing center staff—have been collected. Both quantitative and qualitative instruments were used, including pre- and post-surveys, interviews and focus groups. WATTS' effects on student writing have been assessed by the comparison of pre- and post-tutoring reports using a normed rubric and have demonstrated statistically significantly improvement in student writing.

The results are being used to develop a replicable, sustainable model for dissemination to other institutions and application within other STEM fields. Increasing collaboration between engineering instructors and writing centers is a desirable outcome and essential for WATTS dissemination to a broad audience. NSF funding of this project has enabled the investigators to expand WATTS to additional engineering courses, test key factors with more instructors, and refine the process. It is anticipated that the study will contribute valuable knowledge to facilitate the improvement of student writing in STEM fields.

As the cost of higher education increases, institutions are pressured to graduate students in four years while engineering curricula are becoming more complex. WATTS presents an economical, effective method to improve student writing in the discipline. Several factors indicate that it has the potential for broad dissemination and impact and will provide a foundation for a sustainable model for future work as instructors become trainers for their colleagues, allowing additional ongoing expansion and implementation. WATTS serves as a model for institutions (large or small) to capitalize on existing infrastructure and resources to achieve large-scale improvements to undergraduate STEM writing while increasing interdisciplinary collaboration and institutional support.

Introduction

Engineers need strong communication skills throughout their careers [1] which is why ABET includes student outcomes such as "an ability to communicate effectively with a range of audiences" within their accreditation criteria [2]. Although undergraduate students have some understanding of its importance, employers are more aware of the need to communicate effectively [3]. Beyond being simply a secondary concern, integrating technical writing into coursework can help students grasp concepts, improve their communication skills, and develop a foundation for future skill development [4]. It also supports the desire of institutions, parents and students to complete their degrees in four years.

Building upon the frameworks of genre theory [5], knowledge transfer [6], and writing across the curriculum/writing in the discipline (WAC/WID) [7], [8], [9] the Writing Assignment Tutor Training in STEM (WATTS) method has been created based on a collaboration between STEM departments (focusing on engineering and engineering technology programs to date) and campus writing centers. With WATTS, instructors and writing center supervisors provide just-in-time instruction to peer writing tutors prior to their sessions with students to review the student's writing assignment, typically a lab report.

Background

WATTS did not begin as a research project, but as a desire to improve student technical writing [10]. After several semesters when the instructor graded reports with poor grammar and a limited ability to persuasively explain the validity of the results obtained, students were instructed to visit the writing center to have their reports reviewed by a peer tutor. The expectation, and intention, was that with the tutors' help, the students would learn how to improve the readability and persuasiveness of their reports. However, even after meeting with the writing tutors, the reports did not improve.

Discussions with the writing center director revealed several issues:

- The peer tutors did not feel confident in their ability to effectively review technical papers and lab reports, as most of were majoring in fields outside of STEM. This led to an imbalance in power dynamic, as the students did not appreciate the value of the tutors' knowledge of writing principles or tutoring experience. Often, the students did not implement any feedback from the tutors.
- The students and tutors had different definitions of content. The tutors considered content to be the prose in the report, while the students considered the data to be the content. This has been identified previously by Nelms and Dively [11].
- The tutors did not recognize the similarities between papers they typically review for students in first-year composition (FYC) courses and discipline-specific papers, i.e., organization and support for conclusions, via knowledge transfer. Many of the same issues identified by tutors in FYC papers occur in technical papers.

Over the course of several years, the instructor and writing center director developed a one-hour WATTS training for the tutors prior to reviewing the students' technical reports. The instructor

would run the training and be supported by the writing center director. Key elements of the training included:

- To acclimate the tutors to the report they were going to review, the instructor contrasted samples of well and poorly written reports, reviewed a glossary of technical terms, the assignment, and a checklist for tutor reference during tutoring.
- Tutors selected for the training had to have completed at least one semester of tutoring and required approval from the writing center director after having demonstrated an affinity for effective tutoring.
- The instructor focused on the value that the tutors could provide to the students, which helped to rebalance the power dynamic between the tutor and student during the tutoring session.
- The writing center director focused on how the tutors' prior experience tutoring FYC papers prepared them to effectively tutor technical reports.
- Both the instructor and writing center director emphasized the importance of the analysis section of the report, including how the students needed to persuasively explain how their results and data were correct.

After the first training, the following positive impacts of the WATTS method on the tutoring session were observed:

- The average length of the tutoring sessions increased, indicating a stronger desire by the student to engage with the tutor,
- There was a substantial increase in the number of optional free-form comments tutors made about the students' reports as recorded on a post-tutoring evaluation. The content of the comments addressed content issues, whereas before WATTS they were primarily about grammar and punctuation.
- Qualitative feedback collected from the students via an evaluation survey tended to be more positive, and
- The self-efficacy of the tutors noticeably improved, with some tutors becoming interested in technical writing careers. Also, most tutors voluntarily returned in subsequent semesters for WATTS training.

Methodology

The initial results were compelling, but not statistically robust. A more expansive study was proposed, as this project has the potential to advance knowledge in STEM education and related fields by providing new information about the efficacy of instructor and writing center interdisciplinary collaborations to strengthen tutor skills and, ultimately, to improve student writing in disciplinary contexts. More broadly, several factors indicate that this project will provide a foundation for a sustainable model for institutions (large or small) to capitalize on existing infrastructure and resources to achieve large-scale improvements to undergraduate STEM writing while increasing interdisciplinary collaboration and institutional support.

An expansion of the research team across multiple campuses provided the opportunity to assess the value of the WATTS method with a statistically robust data set. Two research aims were identified. The aims and a description of the effort to fulfill them follows.

Research Aim 1 - Determine the impact of WATTS on student- and tutor-level outcomes. Identify mitigating and moderating effects of WATTS using data from students and tutors. To determine the effectiveness of the WATTS training on student writing, student reports at four campuses were evaluated based on the following levels:

- Baseline reports – Students did not receive tutoring,
- Control reports – Students met with a tutor who had not been trained using the WATTS method, and
- Experimental reports – Students met with a tutor who had been trained using the WATTS method.

The reports were evaluated with a modified American Association of Colleges and Universities (AAC&U) VALUE rubric for written communication provided in Appendix A. The assessment team that performed the evaluation was trained in the use of the rubric, which has five criteria for evaluation and four rating levels. The criteria are:

- Context of and Purpose for Writing,
- Content Development,
- Genre and Disciplinary Conventions,
- Sources and Evidence, and
- Control of Syntax and Mechanics.

Baseline report data were collected during the first year of the grant at four campuses:

- Indiana University – Purdue University Indianapolis (IUPUI)
- Indiana University – Purdue University Columbus (IUPUC)
- Penn State Behrend (PSB)
- University of Texas Rio Grande Valley (UTRGV)

Control data were collected during the first and second years of the grant at these campuses. Experimental data was collected in the second and third year of the grant at these campuses. At Penn State Behrend, experimental data was also collected during the first year. WATTS had been originally developed at PSB and one of the programs in which it had been implemented had reached that level of maturity in its processes.

Two members of the assessment team evaluated each report. If the level of attainment for each category was not within one by both members, then the members would meet and discuss the score discrepancy and come to consensus. This time-intensive process ensures that the VALUE rubric is effectively employed to identify the level of competence demonstrated by each student in each category for every report submitted.

Survey data was also collected each semester from various participants in the study as follows:

- Instructor Pre-Participation survey,
- Instructor Post-Participation survey,
- Student Pre-Participation survey,
- Student Post-Participation survey,
- Tutor Pre-Training survey,
- Tutor Post-Training survey,
- Tutor Evaluation of Tutoring Session Survey

At an institutional level, the additional effort required to implement WATTS is not substantial. During the first iteration of WATTS, the instructor will need to assemble material to support the training session, including the lab reports, glossary of terms, and the assignment with grading criteria. These materials can be used in subsequent semesters. The writing center supervisor will need to identify appropriate tutors for the training, coordinate the tutoring session schedule, and coordinate the collection of any survey data. The additional tutoring sessions are considered a benefit to both the students being tutored and the writing center given the additional activity.

Research Aim 2 - Determine the impact of WATTS on instructors and on writing center outcomes to enhance the implementation, training, and development of WATTS.
A standardized training manual for instructors and writing center directors has been developed and implemented. A flowchart of the elements within the WATTS training method is provided in Appendix B.

A total of four writing center directors and six instructors have been trained by the researchers. The training covers the following principal topics:

- The benefits of WATTS to writing centers, instructors, tutors, students, and departments,
- The logistics of the collaborative partnership between the instructor and writing center director before, during and after the WATTS training,
- The documents the instructor generates in preparation for the WATTS training,
- Tutor selection guidelines for the writing center director,
- Survey instruments for assessment and distribution schedule for administration, and
- Instructions on conducting the WATTS training.

Results

Tables 1 – 3 provide results from evaluating baseline, control, and experimental reports using the modified AAC&U VALUE rubric, respectively. Only the experimental reports, where the students received feedback from a WATTS-trained tutor, showed a statistically significant improvement in the various categories of the report when the revised report was submitted and analyzed.

TABLE 1

AAC&U RUBRIC SCORE DESCRIPTIVE STATISTICS
FOR BASELINE STUDENT REPORTS

	No Tutoring Visit All Campuses (N = 92)	
Criteria	M	SD
Context of and Purpose for Writing	1.65	.767
Content Development	1.63	.827
Genre and Disciplinary Conventions	1.76	.782
Sources and Evidence	0.41	.620
Control of Syntax and Mechanics	2.05	.696

TABLE 2

AAC&U RUBRIC SCORE DESCRIPTIVE STATISTICS
FOR CONTROL STUDENT REPORTS

	Pre-Tutoring Visit All Campuses (N = 70)		Post-Tutoring Visit All Campuses (N = 92)	
Criteria	M	SD	M	SD
Context of and Purpose for Writing	1.43	.4997	1.53	.543
Content Development	1.40	.480	1.67	.553
Genre and Disciplinary Conventions.	1.41	.490	1.56	.598
Sources and Evidence	0.59	.710	.61	.700
Control of Syntax and Mechanics	1.90	.581	2.06	.627

TABLE 3

AAC&U RUBRIC SCORE DESCRIPTIVE STATISTICS
FOR EXPERIMENTAL STUDENT REPORTS

	Pre-Tutoring Visit All Campuses[1] (N = 63)		Post-Tutoring Visit All Campuses[1] (N = 63)	
Criteria	M	SD	M	SD
Context of and Purpose for Writing	1.76	.507	2.00	.539
Content Development	1.69	.542	2.15	.551
Genre and Disciplinary Conventions.	1.68	.459	2.00	.508
Sources and Evidence	0.68	.800	1.01	.868
Control of Syntax and Mechanics	2.12	.367	2.35	.388

[1] IUPUC was omitted from the AAC&U rubric score descriptive statistics for experimental student reports for the preliminary results because control and experimental data were collected in the same semester.

Conclusions

The analysis is continuing for experimental reports written during the current academic year. From the data collected and analyzed to date, there is a statistically significant improvement in student writing from assessing the various criteria in the modified AAC&U VALUE rubric. Further assessment, based on additional reports, allows for a more robust statistical data set. However, given that there are four participating campuses, as well as a limited number of personnel to do the report assessment, it is recognized that the amount of data accumulated on the current grant may be less than preferred.

Given the results from the implementation of WATTS to date, broader dissemination of WATTS appears to be the next logical step. WATTS is a low-cost means of writing support for STEM students. Expansion to other campuses and disciplines, using a self-sustaining model such as the one employed in Supplemental Instruction may ensure that the value WATTS provides is able to endure.

Acknowledgement

The authors are grateful to the National Science Foundation for their generous funding of this effort at PSB, IUPUI, and UTRGV. The authors are also grateful for the lasting contributions of Mr. Jon Meckley, who was not only a key contributor to this research effort but also a kind, witty, and caring human being. He will be greatly missed.

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Appendix A

Modified AAC&U VALUE Rubric for Written Communication

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

Elements of WATTS Interdisciplinary Peer Tutor Training Session
Trainers: WATTS Trained Instructor and Writing Supervisor