

Rubrics for Formative and Summative Student Writing Assessment in Industrial Engineering

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Abstract

The use of writing assignments in the industrial engineering classroom is often avoided by faculty because of the high workload associated with providing feedback to students on writing assignments. In this paper, we present a variety of rubrics that were developed for use in a junior-level industrial ergonomics course. The goal of using the rubrics is to provide clear expectations and valuable feedback to the students, while also providing an efficient grading mechanism for the instructor. The examples include rubrics for both formative and summative assessments. Instructor and student perspectives regarding the use of these rubrics will be presented. Finally, we will discuss how to modify the rubrics for inclusion in a variety of engineering courses.

Keywords

Student Writing, Rubric, Evaluation

The Case for Rubrics

A rubric is a tool used to evaluate the quality of student work, often by evaluating student responses against predetermined criteria^{1,2}. Rubrics have been shown as effective tools to evaluate writing in engineering education^{1,3}. The benefits of using rubrics are varied. One benefit is the rubrics allow for instructors not well-versed in writing and composition to provide valuable writing feedback to students³. There is also research suggesting that the use of rubrics positively improves student's performance on writing assessments^{4,5}. This is especially apparent when students refer to the assessment rubrics throughout their writing process⁶. Rubrics can be used for both formative and summative assessments⁷. Formative assessments are useful for providing feedback to students so that they can further improve their learning. Summative assessments are more evaluative, used to determine successful achievement of student outcomes or learning objectives, typically at the end of an instructional period.

Course Information

Rubrics were developed and implemented in a junior-level engineering course, Industrial Ergonomics. The course enrollment in fall 2018 was 54 undergraduate students. As upper-level students, most had completed the English composition two-course sequence, but had not yet taken the engineering-specific technical communication course. The course included a writing intensive project, worth 25% of the course grade. The writing-intensive project was introduced

into the course as part of the university strategy to increase quality in student writing. The topic of the course is ergonomics, and students were tasked in their projects with providing a detailed design recommendation to a provided ergonomics problem. The recommendations were to be persuasive, leading the reader (decision maker) to the preferred conclusion. The project included multiple student drafts, with feedback from others, that lead to the final paper submission, as shown in Figure 1. All rubrics were provided to students in advance, so they could refer to them for writing guidance.

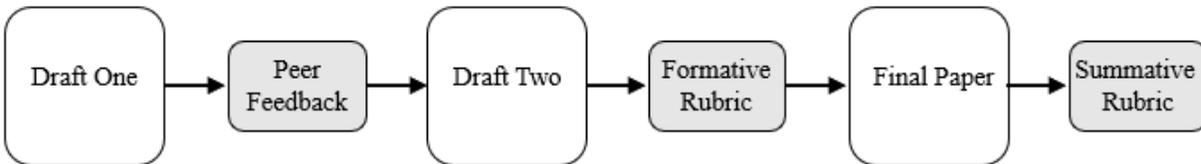


Figure 1. Student submissions and feedback

Formative Rubric

The formative rubric was developed collaboratively between the course instructor and a university writing coordinator. The formative rubric was created with the primary goal of providing valuable and timely feedback to each student writer to encourage additional revision and writing improvements. It was also created with the secondary goal of minimizing grading time for the instructor, given the large class size. The rubric was used to grade students' second drafts of their papers, which had already received edits and revisions from peer review.

The formative rubric (Appendix A) lists the primary expectations of a well-constructed paper. Beside each expectation, the instructor circles a plus or minus sign. A plus sign indicates that the student is meeting that expectation. A minus sign indicates that the student needs to significantly improve that portion of the paper. The instructor provides a holistic assessment of the paper. If it were turned in as a final paper at that time, what the final grade would be. There is a rubric section for "off the top" points. These are points deducted from a student's draft paper score if instructions were not followed. Finally, there is space for instructor comments.

Summative Rubric

The summative rubric was also developed collaboratively between the course instructor and a university writing coordinator. The summative rubric was created with the goal of providing a final grade to the student's writing, now that the time for revision was completed. The use of feedback by students at this point in the term was not expected. The final draft of the students' papers was to have significant revisions from the second draft, which was evaluated using the formative rubric.

The summative rubric (Appendix B) has a continuous number rating scale for each major paper component. The instructor circled the appropriate rating for each component, then summed the numbers for a final paper score. The text on each scale helped to anchor the ratings, and demonstrated examples of varying writing quality for each component. The continuous nature of

the scale allowed instructor discretion in evaluation, while also standardizing grades. Finally, the rubric contains space for instructor comments.

Student Performance

The average projected grade from the draft paper, graded with the formative rubric, was 79.81 points (on a scale of 100). The average grade on the final paper, graded with the summative rubric, was 86.06 points (also on a scale of 100). This average increase of 6.24 points from the draft submission to the final paper demonstrates an effective use of the formative feedback by the students. Figure 2 shows the increase in letter grades on the final paper compared to the draft paper.

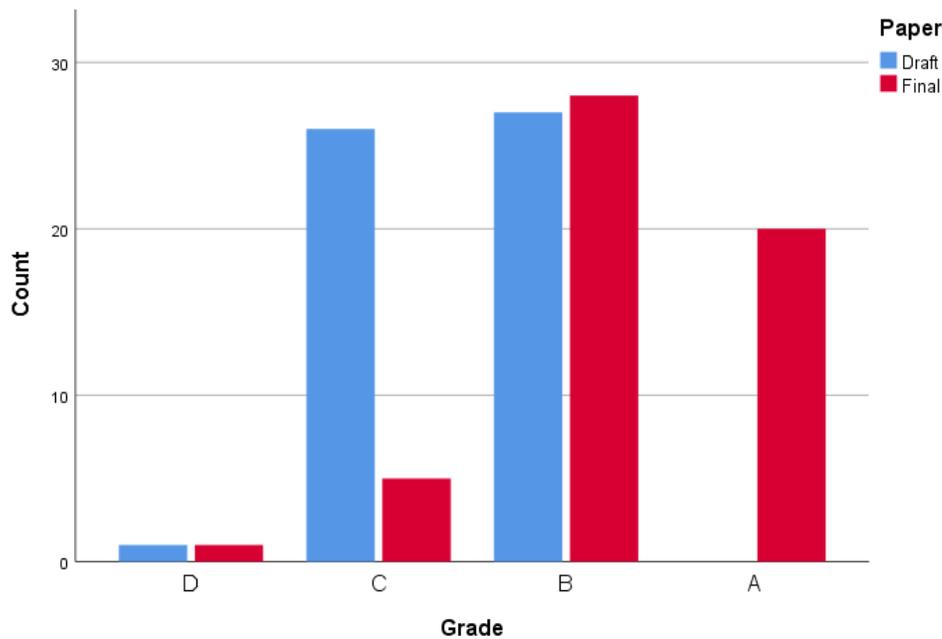


Figure 2. Bar chart of grades by paper type

Anecdotal Feedback

For this course, the length of the papers was 3-5 pages. With over 50 students in the class, completing copy editing and detailed feedback for each student draft is time prohibitive. The formative rubric allowed the instructor to give focused and actionable feedback to the students, with a time commitment of about ten minutes per student. The binary selection (plus or minus) was a bit tenuous at times, so a midpoint was often used. In future terms, a neutral category can be added. Additionally, students were instructed that a plus mark did not indicate perfect writing, but rather meeting expectations. Students were initially skeptical of the formative rubric. However, they responded well to the feedback. The minuses they received helped them focus their revisions. Many students visited office hours for more guided feedback, which had not traditionally happened with more detailed paper editing. Additionally, the projected grade served as a strong motivator for students to continue revising and editing.

References

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APPENDIX A. Formative Rubric

Problem	+	-	Initial problem is explained well and in detail.
	+	-	Importance of initial problem is noted, along with secondary problems that may arise if initial problem is not addressed.
	+	-	Technical aspects of the problem are explained correctly.
Solution	+	-	Solution is presented in a manner that is immediately implementable. The intended audience will not need to conduct further research for clarification.
	+	-	Solution is appropriate to initial problem and is justifiable.
	+	-	Credible sources are used as a means to provide evidence to the solution.
	+	-	Solution is feasible.
Recommendation	+	-	Persuasive recommendation is included; it is written in such a manner as to persuade the audience that the aforementioned solution is best way to correct the initial problem.
Critical Thinking	+	-	Initial problem, evidence, solution, and recommendation are logically connected by thorough explanation.
	+	-	Credible sources are analyzed and synthesized well; viewpoints of experts are not taken as fact.
	+	-	Initial problem, evidence, solution, and recommendation are all evaluated based on complexity; final position reflects complexity of the issue.
Format	+	-	Report follows the suggested formatting.
Grammar and Syntax	+	-	There are little to no issues with grammar or syntax. Report follows most of the requirements of Standard Academic English
Estimated Grade for Final Paper: A B C D F			
Points Off the Top	-5	The second draft of the paper is the incorrect length (less than 3 pages or more than 5, single spaced).	
Additional Comments			

APPENDIX B. Summative Rubric

Purpose																									
The issue to be addressed is explained in detail. There is a clear explanation of the problem and clear reasoning for why the problem needs to be addressed.								The issue to be addressed is explained. There is some explanation of the problem and some reasoning for why the problem needs to be addressed.								The issue to be addressed is not explained or is explained poorly. There is little to no explanation of the problem and there is little to no reasoning for why the problem needs to be addressed.									
25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Content																									
The report details a solution to the problem that utilizes appropriate ergonomics concepts. The ergonomics concepts are correctly interpreted in detail. The solution is feasible.								The report has a solution to the problem that utilizes ergonomics concepts. The ergonomics concepts are somewhat correct in interpretation, and they are described in some detail. The solution may be feasible.								The report may mention a solution, but it is vague or close to non-existent. The ergonomics concepts are incorrectly interpreted. The solution is most likely not feasible.									
25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
The report contains a detailed and persuasive recommendation. The recommendation is supported by appropriate evidence and leads the audience to the desired outcome.								The report contains a recommendation that has some detail and is somewhat persuasive. The recommendation is somewhat supported by evidence and may lead the audience to a desired conclusion.								The report contains a non-persuasive recommendation or no recommendation at all. The recommendation is supported by little evidence or no evidence at all; it does not lead the audience to a desired conclusion.									
15	14	13	12	11				10	9	8	7	6				5	4	3	2	1	0				
Critical Thinking																									
Sources used in the report are credible. Sources are well represented through appropriate and seamless analysis and synthesis. Multiple viewpoints are considered and limitations of perspectives are explored.								Most of the sources used in the report are credible, but they do not create a seamless analysis or synthesis. Multiple viewpoints may be considered, but the limitations of perspectives are not mentioned.								Sources used are questionable. There is little to no synthesis or analysis. A single viewpoint is considered, and the limitation of perspectives are not considered.									
			10	9	8	7				6	5	4	3					2	1	0					

APPENDIX B. Summative Rubric (continued)

Formatting										
The report is the appropriate length with correctly formatted section headings and cover page. All figures and/or charts are properly labeled.				The report is slightly less or more than the given length of the assignment. There is a cover page and section headings, but they may have errors. Some figures and charts are properly labeled.				The report is notably shorter or longer than the given length of the assignment. There is no cover page and / or section headings. Figures and charts are either not labeled, or very few are labeled properly.		
10	9	8	7	6	5	4	3	2	1	0
All sources used within the report are cited correctly. Each citation in the report pairs with an appropriately formatted reference on the reference page.				Some sources are cited correctly in the report, and some references are appropriately formatted on the reference page. Some vague citations may be present, or there may be some uncertainty in the origin of some information				Multiple errors in citation usage or in formatting of reference page. Citations may not be used at all or not frequently enough. References may be missing.		
5	4			3	2			1	0	
Grammar and Style										
The report contains little to no grammatical or syntactical errors. Tone is appropriate for the task.				The report contains some grammatical or syntactical errors, but those errors do not impede meaning. Tone is mostly appropriate for the task.				The report contains grammatical and syntactical errors that impede meaning. The tone is not appropriate for the task.		
10	9	8	7	6	5	4	3	2	1	0
Comments:										
									Total Score:	