

Assessment of Technical Writing and Synthesis of Course Topics Utilizing a Standardized Rubric

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Abstract

Strong communication has been identified by many sources as a critical skill for college graduates. While these communication skills are developed throughout the undergraduate curriculum, this paper focuses on a single course within the first semester of the senior year. In this class students are required to read several journal articles and complete associated brief writing assignments prior to class discussions. The method for assessing each writing assignment is a detailed rubric which is presented at the beginning of the semester and applied to all submissions. This paper discusses the reason behind and development of the rubric, the assessment of student technical writing and synthesis of course topics as a function of time throughout the semester, and an evaluation of the initial use of this rubric grading method in the course. Results found improvement in overall class performance as well as improved performance by a majority of individuals.

Key Words: rubric development, standardized rubrics, rubric grading, technical writing, course assessment

1. Background

In engineering, as in many majors, the development of effective communications skills is an essential element to a well rounded education. Several organizations have stressed the importance of communication during the period of higher education. The National Academy of Engineering (NAE) summarizes several key attributes of the “Engineer of 2020”, with communication as one of these necessary skills (NAE, 2004). The Accreditation Board for Engineering and Technology (ABET) recognizes as one of their assessment measures students’ “ability to communicate effectively” (ABET, 2011) and the Civil Engineering Body of Knowledge (BOK2) also highlights effective communication as one of the necessary professional outcomes (ASCE, 2011). Additionally employers regularly emphasize communication as a needed and valuable asset for individuals looking to join their organizations.

General communication skills include both written and oral, with a focus on developing both of these areas a continual process throughout the undergraduate years. This study focused on written skills in a first semester senior level engineering design course. During the semester, students were asked to read several journal articles focused on contemporary topics relevant to course coverage. Students were responsible for reading the articles independently and were required to come to class prepared to discuss the article in what has been termed “roundtable discussions”. The roundtable discussions were initially implemented in the fall of 2009, in a format that included only reading and class participation in discussions. While many students recognized the importance of these activities, and participation was acceptable, one of the main changes the instructor wished to implement was an increase in student participation to enhance discussions and improved student organization of thoughts prior to class to promote a higher level of topic comprehension (Kunberger, 2010).

To this end, brief writing assignments linked with each article were developed. The method for assessing each of these assignments was identical – a detailed rubric presented to the students at the beginning of the semester and applied to all written submissions for the roundtable discussions throughout the semester. Students were not only able to see the rubric prior to submissions, but once graded students had the ability to see which achievement level they reached for each of the criteria, allowing them the chance to focus on the weaker areas in order to strengthen future submissions.

2. Rubric Development

Rubrics can and have been developed as assessment tools for a variety of assignments and activities in the college and university classroom and a number of sources (e.g. Moskal, 2000a, 2000b; Stevens and Levi, 2005; Jonsson and Svingby, 2007) exist to assist professors with rubric development as well as to demonstrate the validity of the rubric model.

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Within engineering rubrics have been utilized for lab reports (e.g. Powe and Moorhead, 2006), critical thinking (Ralston and Bays, 2010), and particularly in capstone senior design courses (e.g. Hurtig and Estell, 2006; Gibson and Brackin, 2007). The rubric developed and discussed in this paper is focused on a specific assignment (roundtable submissions) and primarily for the evaluation of technical writing.

Prior to the start of the semester, and based on the results of the initial roundtable discussion forums, the instructor developed a rubric which reflected the desired areas of focus. The rubric contains five achievement levels (from beginning through accomplished) and five distinct criteria (critical points, course relation, author qualifications, clarity and completeness, and synthesis and contribution). Criteria are general enough to be applicable to the variety of discussion topics, yet specific enough to detail a given focus area and delineate between particular competence areas. A relative weight was applied to each of the criteria, which are discussed in more detail in the subsections below. Additionally, each achievement level was assigned a certain percent of the overall points available for that criterion.

The five achievement levels include beginning, developing, adequate, competent, and accomplished. Relative percentages for each were assigned based on the rubric being used for a senior level course. The expectation for seniors is that they should be in the adequate to accomplished range, with little or no criteria in the developing or beginning range. Because of this, percentages for beginning (10%) and developing (40%) are below that required to achieve a passing grade while adequate (65%), competent (80%), and accomplished (100%) all have percentages correlated to letter grades of “D” (adequate – minimum required to pass the course), “B” (competent – above expectations for course work) and “A” (accomplished – significantly above expectations for course work).

The overall rubric, including weighting for all criteria and weighting and expectations for each achievement level, is presented in Figure 1. Further details on criteria areas and “accomplished” level requirements are presented in the subsequent sub sections.

2.1 Critical Points

The critical points criterion, with a relative weight of 35%, is the largest of the five coverage areas. This criterion relates directly to the key points, assessing whether or not a student can determine what is most important in a specific article. Expectations for the accomplished level of this criterion include the ability to recognize and detail important points of the article as well as illustrating a relationship between points within the article as well as points within other sources. Additionally, “accomplished” work will acknowledge any implicit limitations associated with the presented results and or discussion in the article. Information for this section is gained almost exclusively from the article itself, with students needing to be able to comprehend topic coverage as well as discern and prioritize various points. The identification of critical ideas is typically easy for the students, while recognizing relationships and limitations being more complex.

2.2 Course Relation

At a relative weight of 20%, the course relation criterion encourages students to relate the articles to the course in an effort to answer the question, “Why is this article being read?” Students presenting a clear and well developed relationship of the discussion topic to course objectives reach the “accomplished” level for this criterion. Often the course objectives to which an article relates are those that are currently being covered. Some articles apply to only one or two specific course objectives, while others are broader in scope and relate more to the course in general than any single specific objective. This section necessitates linkage development between the articles and the course. Students must not only identify critical points of the article, but now must also recognize important course topics and link these two areas in a coherent manner.

2.3 Author Qualifications

Articles under discussion in the course come from a variety of sources. Many are journal articles, while others are refereed conference proceedings, and some white papers or final reports which may or may not be formally published. Some are more historical in nature, while others are from conferences and publications within the last six months. Because of this the background and experience of the authors varies dramatically. For example, the author of the first article students read is one of the foremost researchers in the course coverage area – with decades of experience, countless publications and awards, and significant contributions to the field; while authors of other papers have only held a degree for a year or two and have more limited experience. An “accomplished” level submission includes a recognition of and appreciation for the merits of the author.

This criterion often requires students to perform external searches, as the article itself rarely provides a significant amount of information on the author or authors. Additionally, students begin to gain an appreciation for the gradation in the reliability of source information and an appreciation not only for educational background but also the significance of field experience.

2.4 Clarity and Completeness

The weighting of 25% for clarity and completeness is primarily due to the stress the instructor wishes to place on the importance of quality writing. The requirements needed to reach an accomplished level are simply a paper that is clear, concise, and well written, free of spelling and grammatical errors with a smooth and logical flow. Many of these requirements necessitate, at minimum, a final read-through prior to submission, and may require more substantial revisions depending on the students' writing ability. With the level of group work occurring in many classrooms today, the final polishing step on submissions is rarely completed by every student. Groups often select the strongest editor to compile and complete the work, without necessarily recognizing the level of effort that goes into the final steps. As roundtable submissions are individual assignments, every student in the class becomes responsible for this final polishing effort.

2.5 Synthesis and Contribution

Synthesis and contribution is probably the most challenging of the criterion presented. Because of this, the weighting of 10% allows students who reach "accomplished" in all other criteria and attempt this area to earn an "A" on the submission. An "accomplished" level of work for this criterion is highly organized and illustrates the big picture as well as finer details. The submission shows strong links to both previous topics and the future direction, and includes unique insights, presenting personal observations in addition to article information.

3. Rubric Application

As presented in the background section, roundtable activities were initially developed for the fall 2009 offering of the course. Based on student feedback and instructor observation, it was determined that additional expectations needed to be implemented in order to enhance the experience and truly achieve the desired objectives. This led to the addition of writing assignments linked to roundtable articles and the development of a rubric to convey expectations and assess submissions. The rubric allowed the instructor to clearly present desired expectations for every achievement level for all of the stated criteria prior to student submissions, as well as provide feedback on the level of student achievement in each criteria (and grading) after submissions.

As an additional benefit for the instructor, the rubric itself was developed in the course management system (CMS), which allows students to submit electronic files and links these files with the desired rubric. Grading within the CMS simply requires the instructor to open the "grade using rubric" file and click on the appropriate cell for each of the specified criteria. Once a cell in each criteria is highlighted, the instructor can hit the "save" button. This will automatically calculate the grade and link it to the grade book, as well as display the graded rubric to the students allowing them to see which areas are strengths and where to focus future submissions for improvements.

While initial development of the rubric required a couple of hours of instructor time, this time was easily balanced by the reduced grading time. The detailed rubric also allowed for a reasonable amount of feedback to students for a relatively small amount of instructor time (i.e. the amount of time it took for the instructor to highlight rubric cells was considerably less than what it would take to provide written feedback to each student, while from the student perspective the achievement levels reached were sufficiently detailed within the rubric to provide adequate information to direct future submissions).

4. Rubric Implementation

Roundtable activities occur in a senior level Geotechnical Engineering II course. This course is the second in a two course sequence which is required for all civil engineering majors. The fall 2010 offering enrolled 47 students in 2 sections of the course, both taught by the same instructor. This was the second semester roundtable activities occurred, and the first in which a written component was required. A total of nine roundtable activities occurred during the fall 2010 semester. Of these, six incorporated a written assignment which was assessed and graded utilizing the rubric presented (the others required in class quizzes with questions similar to rubric criteria).

All roundtable articles were posted to the CMS at the beginning of the semester. The rubric was presented on the first day of class and discussed in detail, with time allowed for student questions.

The rubric was made available as a file within the CMS as well as being a link within all submission drop boxes. Thus students had multiple opportunities to view and review the rubric prior to submitting files. Roundtable activities took place during the second half of Wednesday classes, with one or two weeks between expected submissions. Significant effort was made by the instructor to provide feedback on submissions prior to the due date of subsequent submissions. This was accomplished for 4 of the 6 submissions, while for the others students were required to base their expectations on feedback from earlier submissions but without feedback from the most recent submission. Since submissions were based on distinct articles, feedback from one submission was applicable only in the most general sense of the criteria and thus beneficial, but not critical, for the improvement of future submissions.

5. Assessment of Student Performance

In general overall class performance, as well as individual student performance, increased over the course of the semester. Considering all students (47) in both sections of the course, the average on roundtable submissions increased from an 80.2% on the first submission at the beginning of September to 90.8% for the mid October submission, or an increase of approximately ten percentage points. The overall average for all six submissions increased from the 80.2% on the initial submission to a final overall average of 86.2%, demonstrating a six percent increase. When considering the achievement levels on the rubric, this places the class average in the competent to accomplished range for all submissions, with at least some of the criteria at the accomplished level for the overall average and mid October submissions. When considering individual student performance, the difference in the initial submission grade and the student overall average on all submissions is presented in Figure 2 and ranges from - 9.2% to + 34.2%, with an average change of + 6%. Of the 47 students in the course, 36 of the 47 (76.5%) possessed a final average on their roundtable submissions that was greater than their first submission. Of these 36, 13 (36% or 27.7% of the class) improved their average on roundtable submissions by more than ten percent over that of their initial submission, while another 13 posted improvements of between five and ten percent and the remaining 10 showed an improvement of less than five percent.

In looking at the 11 students who did not show improvement from the initial submission to the final overall average, 8 of the 11 maintained an average greater than 90% for all submissions, with all 11 possessing an average of greater than 80%. Thus the lack of improvement was not from the lack of ability, but rather based upon the fact that these students demonstrated strong “accomplished” writing abilities entering the course and had a narrow range in which to improve over the semester. Five of the eleven had an average “loss” of less than 3%, and three of the eleven earned perfect (100%) scores on the initial assignment, almost ensuring an average less than that of the initial submission.

From a qualitative standpoint, the addition of writing assignments prior to class discussions had a notable impact on individual participation. In the initial implementation of roundtable activities, the majority of the discussions were carried by a select group of students. In the second offering, where all students were required to complete individual writing assignments prior to class, a greater majority of students participated in the classroom discussions and the discussions themselves had a clearer focus and higher level of technical detail. Students also were able to express links between earlier articles and subsequent topics, noting how certain points either build upon, support, or contradict previous information. While it is possible that some of the difference came from the different set of students, the instructor also observed that for the three roundtable discussions that did not require written assignments, the discussion level in class was noticeably lower, with less technical detail and fewer global links, with the same students than when writing assignments were associated with the article.

6. Conclusions and Future Plans

A standardized rubric was developed within a required senior level design course to assess written submissions associated with articles students were required to read and discuss in class. The initial results from two sections (forty-seven students total) indicate an average increase of approximately 10% on graded submissions when comparing initial submissions to those later in the semester and an overall increase in the average of 5% when comparing initial submissions to the final overall average for the course. On an individual basis, over three-quarters of the class demonstrated improvement on submitted work, with more than a quarter of the class posting improvements of over ten percent. In future offerings of the course, the instructor seeks to compare not only overall technical writing performance, but also specific criteria performance as a function of time throughout the semester. Additionally the impact of rubric assessment of roundtable activities on other technical writing and critical thinking in the course will be investigated.

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Figure 1: Complete Rubric Developed for Round Table Submissions

Criteria	Achievement Level				
	Accomplished (100%)	Competent (80%)	Adequate (65%)	Developing (40%)	Beginning (10%)
Critical Points (35% Weighting)	35 percent Recognizes and details important points of article. Illustrates relationship between points within article as well as to other sources. Acknowledges any implicit limitations associated with presented results / discussion.	28 percent Recognizes and details most of the important point of article. Some illustration of relationship between points within article as well as to other sources. Acknowledges some implicit limitations associated with presented results / discussion.	23 percent Recognizes and details at least one of the important point of article. Some illustration of relationship between points within article as well as to other sources. May or may not acknowledge implicit limitations associated with presented results / discussion.	14 percent Recognizes and details at least one of the important point of article. May include illustration of relationship between points within article as well as to other sources. May or may not acknowledge implicit limitations associated with presented results / discussion.	4 percent Does not recognize and/or detail at least one of the important point of article. No inclusion of relationship between points within article or to other sources. Does not acknowledge implicit limitations associated with presented results / discussion.
Course Relation (20% Weighting)	20 percent Presents a clear, well-developed relationship of discussion topic to course objectives.	16 percent Presents a clear, somewhat-developed relationship of discussion topic to course objectives.	13 percent Presents a clear, but not fully developed relationship of discussion topic to course objectives.	8 percent Presents a relationship of discussion topic to course objectives which is indirect and/or not well-developed.	2 percent No clear relation to course objectives is presented.
Author Qualifications (10% Weighting)	10 percent Includes a recognition of and appreciation for the merits of the author.	8 percent Includes a recognition of and/or appreciation for the merits of the author.	7 percent Includes a recognition of or appreciation for the merits of the author.	4 percent Notes the existence of an author.	1 percent No recognition / appreciation for the author is included.
Clarity and Completeness (25% Weighting)	25 percent Clear, concise, well written. Free of spelling / grammatical errors. Flow is smooth and logical.	20 percent Clear, concise, well written. Minimal spelling / grammatical errors. Flow is smooth and logical.	16 percent Noticeable spelling / grammatical errors. Flow may be choppy or illogical.	10 percent Noticeable spelling / grammatical errors. Flow is choppy or illogical.	3 percent Significant spelling / grammatical errors. No logical flow or noticeable jumping around when presenting concepts.
Synthesis and Contribution (10% Weighting)	10 percent Highly organized, illustrating big picture as well as finer details. Shows strong link to previous topics and future direction. Presents personal observations in addition to article information. Includes unique insights.	8 percent Well organized, illustrating big picture as well as finer details. Shows strong link to previous topics and future direction. Presents personal observations in addition to article information.	7 percent Well organized, illustrating big picture as well as finer details. Shows link to previous topics and future direction. Includes primarily article information, little if any personal observations included.	4 percent Poorly organized with no illustration of big picture and/or well as finer details. Weak or no links to previous topics and future direction. Includes only article information, no personal observations.	1 percent Poorly organized with no illustration of big picture or finer details. Few or no links to previous topics and future direction. Includes only article information, no personal observations.

Figure 2: Percent Change in Individual Student Grades Comparing Initial Submission to Overall Submission Average (n = 47)

