DESIGNING RUBRICS FOR COMMUNICATION COURSES IN ENGINEERING: *A Work in Progress*

Anne Parker and Aidan Topping
Design Engineering, University of Manitoba

Anne.Parker@umanitoba.ca

Aidan.Topping@umanitoba.ca

Abstract – *This paper will focus on the rubrics that we have developed for the technical communication course and the senior (capstone) design projects. As part of the C.E.A.B.'s and our own Faculty of Engineering's mandate to more clearly define the goals of each course, the learning attributes associated with course content, and how these are assessed, we first developed rubrics that would help us track and assess students' communicative competence. However, we soon learned that our presentation of the information impacts how well students assimilate it. Consequently, in our rubrics for the senior (capstone) design courses, we began to phrase the assignment requirements as action items, as something that must be done; for example, a document's "layout and document design" must use "clear markers to create a visually appealing document," and the illustrations must "communicate design elements and results." In this way, students are encouraged to reflect on their individual performance, and one outcome for them is the opportunity to engage in a meaningful dialogue with the professor. One outcome for the professor is having the means to indicate a student's position on a spectrum of performance. Finally, although linking attributes to learning objectives and determining "competency levels" can be very challenging, we hope to show how the rubrics we have designed may indeed make the task less daunting and more manageable for all stakeholders in the education of our engineering students.*

Keywords: rubrics, communication, engineering, education

1.0 INTRODUCTION

This paper focuses on the strides we have made in clarifying both our assessment practices and our learning outcomes in two courses – the Technical Communication (ENG 2010) course offered in the 2nd year of engineering studies and

the senior design (capstone) class in Mechanical Engineering (MECH 4860). We will first describe the early forays into assessing student work and then move to the capstone course in Mechanical Engineering, where the rubrics we designed help to reinforce the importance of communication in the design process. Our marking of student papers in this capstone class and the concomitant face-to-face coaching sessions have likewise underscored why a document or an oral presentation must function in ways that will "best support the engineering work" [1, p.493].

For this study, we first gathered information by documenting what we were finding in the student papers we marked. Based on what we were seeing here, guidelines and writing tips could then be formulated and distributed in the capstone courses; these, incidentally, have proven to be quite successful. Similarly, the face-to-face coaching sessions opened up the conversation to include things like how rhetorical principles and clear technical writing can indeed support the engineering work. Students may, as Ford and Riley caution, still see the technical work as the "real work" [2, p.80] or they may focus too exclusively only on the communication genres required by a particular kind of project. Nevertheless, we have found that students are quite receptive to any strategy that will move the project forward and help in the exchange of the necessary engineering information [1, p.493]. In the final analysis, we found that presenting the required communication information in a way that helps students assimilate it is, in large measure, the key. So, too, is "a learning environment that is more student-centered, peer-interactive, and teacher-facilitated" [3, p. 201].

2.0 BACKGROUND: THE TECHNICAL COMMUNICATION COURSE (ENG 2010)

Initially, we developed rubrics as a "simple" means to assess student writing. In the past,

students would receive a marked paper back and wonder why all the scribbles were there. Too often, the scribbles would mean very little to them, and they would continue to feel frustrated by what they perceived as impossible standards set by impossible “English” professors. That these professors boasted a background in English only exacerbated matters. What all of us were learning (the hard way) was that what had worked in an English composition or literature class simply wouldn’t work in an engineering communication class. As Irish and Weiss point out, engineering communication is a distinct field and its practitioners – those working engineering professionals and engineering students alike – “like to know how things work” [4, p. v]. Not only that, but students want to know *why* they should do something and they want to know *how* to do it. The scribbled mini-essays that we provided certainly did do many of these things. We would carefully enumerate any of the grammatical errors and then set to work on the weightier rhetorical issues, all the while assuming that our *words* were retrievable by our students. They weren’t. Our mini-essays simply did not convey the needed help our students needed.

Therefore, other attempts were made to make the writing information retrievable. So, for a time, we used “evaluation guides” that gave a symbol and a corresponding explanation. When we wanted to comment on a purpose statement, for example, we would select a symbol and plop it on the page; the student would then find the symbol – and its explanation – on the guide. All that can be said for this method was it did eliminate the scribble and at least students could now decipher the words. But the expected results did not happen. Students still had trouble transferring what the guide said to their own work and then figuring out how to fix a writing problem. We continued to have students admit that they were flummoxed by the comments and even moreso by the grade. The plaintive “where did I lose marks” became a cacophony.

Rubrics offered a pedagogically sound solution. Our initial forays into the world of rubric design, however, resulted in rubrics that were only marginally better. On the one hand, they allowed us to itemize those required elements that student papers needed to have. On the other hand, the scale we used (a “2-1-0” model suggested by a colleague in technical communication at the local community college) meant we had difficulty translating these numbers to a grade that meant something.

Our next iteration began our own design paradigm of defining our problem, exploring alternatives and devising a prototype. We knew the problem (too well), so we worked on eliminating the meaningless numbers and substituting one-word descriptors that would allow us to more definitively assess a student’s level of communicative competence. These descriptors were meant to be non-judgmental; “developing” sounds so much better than “fair” or “adequate.” More than that, we could now track an individual student’s progress over the course of the project or the term; we could see the development as surely as the student could. These descriptors could then be linked to a grade – be it a number, percentage or letter grade. Moreover, we could also link each descriptor to a required element in the writing assignment and thereby assess the writing in a clearer and more definitive way. Finally, including which learning outcomes the rubric addressed, as well as the expected level of competency, helped students see how the communication elements connected to the engineering and, specifically, the C.E.A.B.’s, requirements that graduates demonstrate “an ability to communicate complex engineering concepts within the profession and with society at large” [5].

Meanwhile, the rubrics that we used for the Mechanical Engineering capstone class (MECH 4860) were undergoing similar iterations as we tried to tie assessment both to outcomes and to communicative competence.

3.0 THE CAPSTONE COURSE IN MECHANICAL ENGINEERING

The senior (capstone) design class is the students’ opportunity to use the engineering theory and practical knowledge they have been amassing throughout their undergraduate years in a real-world context, in collaboration with industry partners. Students are tasked with finding a feasible solution to a real world problem; in other words, the educational focus moves to a model in which they learn by doing. As such, students are extremely project-focused and can be somewhat resistant to spending time on matters of rhetoric. Therefore, our involvement in the course has necessarily evolved as we moved through the iterative process of discovering how best to present our feedback and resources to the students.

Initially, we designed a rubric based on the ENG 2010 rubric and in conjunction with the 4860 course coordinator. This cooperation

ensured that we included all the course appropriate requirements as well as integrating our own, rhetorically based criteria for evaluation. In this first version of the rubric (v.1), we covered the requirements for the specific assignment by breaking them down into their constituent parts and placing the student's performance in each area on a five-part spectrum: *not in evidence*, *needs work*, *developing*, *competent* or *exceptional*. Each of the defined elements included a short list of what should be included, and was also assigned a numerical value that could be derived from the student's placement on the spectrum and then converted to a percentage. However, rubric-v.1 only had space for summary comments at the end, and, when using the rubric in practice, we found it difficult to address specific areas of concern concisely. This particular issue also complicated the coaching sessions we held with the students, as they would clamor for clarification of feedback when we needed them to discuss ways to constructively *apply* the feedback going forward. These coaching sessions would then become bogged down in detail and explanations regarding past work rather than focused on the implications of the feedback for future work.

One further area of concern we had with rubric-v.1 was that, in practice, we discovered it was much too heavily weighted toward the negative. In other words, we needed another descriptor. Midway through the term, at which point students had received a good deal of structured feedback, we found that students at this higher level often fell somewhere between "competent" and "exceptional." We also found the distinction between "not in evidence" and "needs work" to be unnecessarily small; for instance, when a student neglected an element completely, we could feasibly check the "needs work" box and allow the numerical grade attached to the element to reflect the distinction.

Thirdly, we found that we were bombarded with student requests to specify why they had lost marks on a certain element, and why, when they had satisfactorily completed the section, they had not received the distinction of "exceptional." From this we discovered that, if nothing else, we needed to clarify for students at the outset that our model was based on a "bottom up" method of applying feedback rather than a "top down" model. While this method clearly differs from most engineering classes, wherein marks are taken off a starting value of 100% for each error, we feel in the field of communication

it is essential that we allow room for the more lateral thought processes that can give students the opportunity to go beyond any specific template they have come to expect and apply their own judgment to the work. Context is key in communication and, if we allow students that flexibility within the course requirements, in essence there cannot be a defined 100% from which to work.

Finally, as we used this type of rubric on the various assignments throughout the year, we noted how one of the most apparent weaknesses in the students' writing was their ability to contextualize information appropriately. As we tracked performance over the year, we could also see that it was an area that was not improving as much as we would have liked, given our focus on communicative competence. We cannot state with any certainty why this was so – whether it was the result of the small numerical value given to the element of "Introduction" in rubric-v.1, or the students' desire to focus on other details in coaching sessions, or the general impression (given by the students) that the technical detail is what "really matters." However, it became clear that any future version of the rubric would have to more clearly define the importance of context.

The next year, we implemented rubric-v.2, with the following changes based upon our experience using rubric-v.1: The "introduction" element was combined with "project objectives" and given a higher numerical value in order to foreground the importance of contextualizing information to achieve communicative competence; the five-part spectrum was changed to reflect the performance of the higher level students, and thus included the designations *needs work*, *developing*, *competent*, *strong* (newly added) and *exceptional*. Additionally, we removed the notations on the value of each descriptor in favor of assigning the appropriate percentage at the outset. We also made our bottom-up grading model more explicit by discussing it in class at the beginning of the term.

What we found was that, while these changes did reinforce the importance of contextualizing information and considering the intended audience, students did not appear to show growth in the area at a higher rate than the previous year when feedback was given with rubric-v.1. The increased percentage for the grade coming from this area seemed to heighten students' attention to it, as evidenced by *longer* introductions, but they were not necessarily any clearer, nor did they provide more of the context

needed. Coaching sessions still seemed focused on covering detail from previous work rather than on moving forward and applying changes, and often our attempts to focus on larger areas of communicative competence (such as organization of information and the ability to concisely explain the relevance of each inclusion) would be derailed by students repeatedly calling our attention back to areas already covered in the feedback.

However, the inclusion of the descriptor “*strong*” proved valuable as both an evaluation for the students to strive for and as a marker to track and demonstrate students’ progress throughout the year. “*Competent*” became the middle ground, an acceptable performance to be sure, but with two levels above it, rubric-v.2 clarified for students the growth possible (and expected) at this higher level. However, we still found ourselves struggling to comment on specific elements concisely, and the rubric would be littered with our tiny scrawls in an attempt to be specific with our feedback without requiring the students to necessarily review the entire document. This led to the same problems in coaching sessions that we experienced with rubric-v.1: a barrage of questions on very specific details, and how the students could attain the higher level/grade.

Accordingly, we included a comment box in rubric-v.3, which allowed us to connect specific notations to a precise element as well as address some of the larger issues. We could also use this space to direct the student to a specific iteration of the problem, concern or, indeed, the well-executed element in his/her own paper, thus giving our own comments the context we require for their ideas. These comment boxes were well received by the students, and in practice cut down on both the number of clarification questions asked and the time spent to do so individually. The comments act as both feedback to the student and aide-memoire to us, as we can more quickly recall the circumstance, which is key when dealing with classes of 75+ students.

While rubric-v.3 worked reasonably well, our meetings with students made us realize that they were using our rubrics (which they have access to prior to handing in assignments) as templates of sorts to follow during the writing process. What this meant in practice was, if we noted that a certain element had seemed unnecessary in a particular instance, then we would hear complaints of “but it was on the rubric!” As each project has an industry specific context, not all projects can realistically have the

exact same requirements. As instructors, we can take that into account and adjust accordingly as we mark the individual assignments, but the students’ tendencies are to follow the rubric as a template written in stone, from which they cannot deviate. Finally, after three iterations of the rubrics, we were *still* fielding frequent inquiries as to what the students had to do in order to acquire the highest level of descriptor.

In order to address these concerns, we realized we needed to clarify for students the developmental relationship between us as instructors and them as learners. We needed to ensure this developmental process was clearly reflected in the rubric, both in its elements and in its *language*. It became clear that the students were not responding to the phrasing of the required elements as laid out in the rubrics, and so we thought about what the students *had* responded well to.

Based on the student meetings and their direct and indirect feedback, we had created some resources for the class in the form of tip sheets and check lists that can be referenced quickly and efficiently both before beginning the writing process and once it’s completed, giving the students specific actions to perform and check for. For instance, regarding the quality of clarity, the tip sheet includes the stipulations to “move from general to specific,” and “include conclusions to summarize information and refresh the most important ideas,” while the checklist, regarding formatting, reminds them to check, for example, that the cover page “includes project title, sponsoring company name, project advisor name, team #, names of team members and signatures.” Once these resources had been made available to the class, we noticed a marked improvement in many of the elements addressed, and student feedback was positive. In fact, an informal exit survey given at year-end indicated these resources had indeed been helpful to the students in the creation of their documents.

The question then became, how can we construct the rubrics to act as both marking/feedback tools *and* as guidelines? In studying the successful tools, we realized that what they all had in common was concision and actionable items. The required elements were phrased as specific actions rather than a more ambiguous list of items. Once we made this connection, it quickly became clear that we could then use this language to indicate the students’ ability to work independently within the larger guidelines. If an item could not apply to a specific project, the language could be

tweaked to indicate they would not be penalized for excluding the element instead of forcing their “round peg” project into a “square hole” rubric, as it were. Further, this change would allow us to more explicitly address and measure the students’ abilities regarding specific outcomes required to meet the communication attributes covered by the class.

Thus, rubric-v.4 was born, and is the current rubric used in the class. Rubric-v.4 was created with a horizontal orientation to accommodate the clarifying changes, which include moving the descriptors so the students see *how* they did before they read through the element itself (to increase awareness of their own performance in relation to the requirement); a separate column for the numerical grade for each element; a box for comments on each element; and, most importantly, clearly phrased actionable items. For instance, in the Conceptual Design Report rubric, the requirements for the introduction, previously given as a more open-ended list (“customer needs, target specifications, and project objectives – overall expectations of the team’s design”), are now written as clear, actionable items. In this instance, students must ensure their introduction “contextualizes the report by providing clear information about the project itself (i.e. do NOT assume the reader can access a previous report), presents a clear statement of project objectives and the overall expectations of the design, identifies customer needs and provides precise technical specifications.” Not only are these requirements actionable, but also the phrasing allows us to address some of the recurring issues, such as contextualizing the project itself in industry, as well as within the timeline of the course (as a progress report, for example), and the precision of specifications. Further, adding phrases such as “when needed,” and “as applicable” provide students the freedom to make the decision whether or not the element is relevant to their specific project.

One of the most important additions to rubric-v.4 was a table included with each returned rubric that delineates what each descriptor really means in terms of the students’ performances. Previously, we had relied on what we assumed was a fairly universal understanding of what the descriptors (like “needs work”) meant. However, we were consistently faced with cries of “but *how* can I become exceptional? What would that look like?” – which, as any instructor will tell you, you can’t always define, but you know it when you see it. Thus, the

descriptor classification table was created to provide students with an appraisal of their current work; at the same time, it provides an outline of how they can achieve the next level and reach for that exceptional level of communicative competence. As well, we also included the numerical equivalents for the descriptors, so our process of deriving a grade from the work was clear to the students. This table, which shows these explicit standards, has led to two important outcomes for us: significantly fewer requests for detailed mark breakdowns and explanations, and more fluid discussions of skill development with students. Table I shows an abbreviated version.

TABLE I: DESCRIPTOR CLASSIFICATION*

Descriptor	Written Performance
Exceptional	Meets & surpasses assignment requirements. Demonstrates the ability to extrapolate from learning experiences and suggests a dedicated involvement with both the material and the writing process. Contains no evidence of errors in process or construction. Organization propels the reader forward through clear, concise explanations/arguments.
Strong	Demonstrates a thorough understanding and effective execution of the required elements. The work is consistent and flows well, demonstrating a good level of engagement with the material and the process.
Developing	Shows evidence of effort, but some elements may be missing, incomplete or misunderstood. Errors in process and/or construction may appear. Language & organization problems may detract from the design project & educe clarity.

*Approximate numerical equivalents: Needs Work- 0-60%, Developing-60-70%, Competent-70-80%, Strong-80-90%, Exceptional-90-100%

While the rubrics in the senior design class have been revised yearly, based on student response to the feedback provided and on our own experience using them, the changes were

incremental enough to allow us to see what worked, and how we could further improve upon the previous models. As a student-focused discipline, technical communication requires that we approach the student in whichever way will allow him/her to benefit the most. Therefore, understanding that the students take information in much more easily when it is presented as an actionable item rather than as an ambiguous statement was critical to our creating a rubric that allowed us to accurately and efficiently provide essential feedback on current communication skills, constructive suggestions for developmental improvement, and the numerical grade required. We can also measure their skills against the required attribute more easily, as the rubric is much more closely aligned with the required elements of the communication attribute to be achieved.

Finally, students responded positively to these changes, which meant fewer requests for clarity, less time spent on small details and more clarity regarding each student's current communicative abilities. What this means is that we are now able to focus our meetings with the students on the larger issues at work in their research and documents. Yes, we address the feedback provided in the rubrics, but we no longer become mired in the detail of it. The evolution of the rubrics has allowed us to be more efficient and student focused, spending our time on larger areas of concern, topics the student specifically feels he/she needs guidance in, and the overarching concern: developing the students' communication skills.

4.0. CONCLUSION

In the final analysis, we can never truly bridge the worlds of the classroom and the workplace – especially if communicative competence can only be gained within the “real” context in which communication skills “must be performed on a daily basis” [6, p. 400]. However, because of the ways in which the design of our communication rubrics have clarified both the assessment and the learning outcomes, the communication component becomes integral to what Brent calls “the larger community of practice” (represented, in this case, by the capstone design project). Students have been engaged in a meaningful way with a

workplace “situation” and have gained “workplace knowledge” based on their interactions with the client and on the communication of that design to the client. The end result is much more likely, then, to be students who are able to work with their industry partners and with a much higher level of communicative competence.

5.0 ACKNOWLEDGEMENTS

The authors gratefully acknowledge the financial support of Mr. Robert A. Kennedy.

6.0 REFERENCES

- [1] Maria C. Paretti, “Teaching communication in Capstone Design: The role of the instructor in situated learning,” *Journal of Engineering Education*, v. 97, no. 4, pp. 491-503, 2008.
- [2] J.D. Ford and L.A. Riley, “Integrating communication and engineering education: A look at curricula, courses, and support systems,” *Journal of Engineering Education*, October issue, pp. 325-328, 2003.
- [3] Chia-Ching Lin and Chin-Chung Tsai, “The relationships between students' conceptions of learning Engineering and their preferences for classroom and laboratory learning environments,” *Journal of Engineering Education*, v. 98, no. 2, pp. 193-204, 2009.
- [4] Robert Irish and Peter E. Weiss, *Engineering Communication: From Principles to Practice*. 2nd Edition. Oxford University Press Canada, 2013, 385 pp.
- [5] The Engineering Accreditation Board. *Accreditation Criteria and Procedures (2008)* [Online]. Available: http://www.engineerscanada.ca/e/files/report_cea_b.08.pdf [April 16, 2012].
- [6] Doug Brent, “Transfer, transformation, and rhetorical knowledge: Insights from transfer theory,” *Journal of Business and Technical Communication*, v.25, no. 4, pp. 396-420, 2011.