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Using Rubrics to Teach Science Writing

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An often-stated goal of education in the STEM (Science, Technology, Engineering, and Math) fields is to teach students to communicate like professionals. In the STEM fields, the single most important thing we can do to teach our students better communication skills is to teach them how to write a lab report. The reason a lab report is so important is not just because it is the end product of a research project, but because each section of a lab report has a particular function that often correlates with different types of communication that a STEM professional needs to use. For instance, the paper's abstract is the same as a brief summary often included in reports, on websites, in news briefs, and which is shared with prospective students. The introduction contains information needed to justify why they're doing their work, which is an important component of a grant proposal. The data and results section is the information that is needed to determine where a research project should go next. This section is also an important component of a grant proposal, because it shows that a researcher actually can do the research proposed. The conclusions and summary section matches the type of information needed to show new students the models and future experiments that they will be working on. While this is not a complete listing of all the functions of a lab report, it should give an idea of its complexity.

Since a lab report is so complex, understanding how to teach it can be a daunting task. In fact, many STEM faculty simply assume that it

is not their job to teach the students to write and leave it to other faculty. The faculty often say things like: "My job is to teach my students the facts about …" or "I'm trying to teach my students to analyze this, and we don't have time to teach writing." The problem with leaving the teaching of writing exclusively to other faculty is that while basic grammar and language skills can be taught by other faculty, the specific layout, structure, style, and language are often specific to the STEM fields. Because of the disciple-specific nature of a STEM lab report, it is critically important that faculty teach their students to write lab reports themselves.

The question, then, is how we help our STEM faculty teach their students how to write a research paper. The teaching process in this case is very similar to the teaching of any skill. We must know what the end product will be and how it will be used. We must know our learning goals and articulate those goals clearly to the students. The student's work will then need to be consistently and clearly assessed. Based on the assessment received. students can then improve their work. The easiest way for teachers to understand their learning goals, articulate these to their students, and then use their learning goals to assess the students work is through the use of a rubric. As Walvoord and Anderson said (1998), "Having clear criteria and standards can:

• Save time in the grading process
• Allow you to make that process consistent and fair
• Help you explain to students what you expect
• Show you what to teach
• Identify essential relationships between discipline information and processes
• Help students participate in their own learning, because they know what they are aiming for
• Help students evaluate their own and each other's work
• Save you from having to explain your criteria to students after they have handed in their work, as a way of justifying the grades they are contesting
• Help student peers give each other constructive feedback on plans and drafts
• Help team teachers or teaching assistants grade student papers consistently

• Help teachers of sequenced courses communicate with each other about standards and criteria
• Form the basis for departmental or institutional assessment."

In this essay, I will use rubric to denote an assessment tool that states what is needed to satisfy the learning goals associated with a given assignment that allows students to achieve the articulated goals of the course. I developed the following rubric for use in an introductory science class. The learning goals behind this rubric are as follows: 1) The student will use a style and layout that is consistent with a professional lab report, 2) The student's writing should place the research in context, including what came before and where will it we go next, and 3) The paper is a critical analysis of the facts, not a listing of them, therefore, the student should show her/his analysis and evaluation of the results. The final product will be a lab report that is written for someone knowledgeable in the field under investigation.

I used the method put forward by Lloyd-Jones (1976) called Primary Trait Scoring to construct this rubric. The rubric has two main components: the traits I want students to exhibit and the point scale used to grade them. The rubric contains seven traits and criteria of achievement that are aligned with each of the four points that can be earned. The seven traits are: Title, Abstract, Introduction, Data and Results, Conclusions and Summary, Materials and Methods, and Grammar and Spelling.

Scientific Lab Report Rubric (EXAMPLE)

Title of Report:

Authors' names:

	Beginning 1	**Developing** 2	**Accomplished** 3	**Exemplary** 4	**Score**
Abstract & Title	Either the Abstract or title are missing	Title does not identify the work. Abstract only a listing of facts	Title identifies the project. Abstract does not include all sections of the report	Title clearly identifies the main question solved. Abstract includes all sections of the paper and is a coherent whole that can be understood	

				on its own.	
Intro	Does not include background or previous work does not identify the purpose, the project, or the question(s) being addressed	Gives very little background or information. May include the question(s) but does not identify their purpose for addressing them	Gives a listing of the facts and previous work but does not tie them together and show how they lead to the purpose of the present work and the questions being addressed. It does have the question(s) being addressed and some purpose for doing them.	Presents the background information and previous work in a concise manner that directly leads into the question(s) being addressed and the purpose of the research.	
Data & Results	Figures missing information and are inaccurate. Either titles or legends missing from figures.	Data appears accurate. Figures missing titles and/or legends.	Data is accurate and presented in a clear fashion. Both Titles and legends are present.	The figures contain all the information needed to understand the data. All the figures flow in a clear and understandable fashion.	
Conclusion & Summary	Presents an illogical explanation for findings and does not address any of the questions suggested in the template.	Presents an illogical explanation for findings and addresses a few questions.	Presents a logical explanation for findings and addresses some of the questions.	Presents a logical explanation for findings and addresses the questions. Additionally, suggests what the next experiments would be.	
Material & Methods	Not sequential, most steps are missing or are confusing.	Some of the steps are understandable; most are confusing and lack detail.	Most of the steps are understandable; some lack detail or are confusing.	Presents easy-to-follow steps which are logical and adequately detailed.	
Grammar & Spelling	Very frequent grammar and/or spelling errors.	More than two errors.	Only one or two errors.	All grammar and spelling are correct.	
Timeliness	Report handed in more than one week late.	Up to one week late.	Up to two days late.	Report handed in on time.	
				Total	

(Source: http://edweb.sdsu.edu/triton/tidepoolunit/Rubrics/reportrubric.html)

In this rubric, the scales (with associated criteria listed underneath) are arranged horizontally. A student can see the criteria for an exemplary report accrue as s/he reads from left to right. (Alternatively, the rubric could be rewritten to function as a skill-based measurement.) It is important to remember that each section of the rubric actually works on a 5-point scale since I have not included the zero, which would be given if the trait were completely missing. The scale is constructed around a traditional A-F grading scale to make it easy for the readers. Specifically, an A=4 points, a B=3 points, a C = 2 points, and a D=1 point. Since there are seven traits in the rubric, the overall grade would be calculated using the following point system: A = 23-28, B = 17-22, C = 11-16, D = 6-10, and F = 0-5. Therefore, if a student earned 4 for the abstract, 2 for the title, 3 for the introduction, 3 for data and results, 2 for conclusions and summary, 3 for materials and methods, and 3 in grammar, the student's total score would be 20, and s/he would earn a B for the paper.

To use the rubric, the faculty would distribute it to the students before the assignment is due or they discuss it in class. Then, during the class session on writing a lab report, the faculty would refer to the specific parts of the rubric when discussing each section. For instance, when the faculty member is showing the students how to write a title, s/he may use the following examples:

Example 1: Yeast die when exposed to light for a long time.
Example 2: Viability of *Saccharomyces cerevisiae* exposed to a time UV-C light.

The teacher would then work through the rubric while grading the examples in class. That explanation would look something like this: In example 1, we know we are looking at yeast; however, we do not know which kind of yeast. Similarly, we know that the yeast is exposed to light but, again, we do not know what kind of light. We know we are looking at dead yeast, so we know that we are trying to study some kind of viability in yeast, but the specifics needed for

context and readability are missing. Therefore, this title would get scored as a 3. In the second example, we start right off with the type of experiment. We know this is a viability study using *Saccharomyces cerevisiae*. Further, we know that we are studying the lethality of UV light in the C wavelength. This title is clear; it lists the experiment specifically and lets us know what the author is doing. Therefore, the title gets a score of 4.

This paper shows how a properly designed rubric can greatly assist faculty in the teaching of STEM lab reports, since it allows students to see clearly what the expectations are at the beginning, middle, and end of the assignment and within each section of the report. Rubrics also allow the teacher to present her/his feedback in a focused and helpful manner. The rubric, adaptable to all sorts of academic writing, acts as a scaffolding for learning distinct genres in written academic literature, and as such, will naturally 'fall away' as the student internalizes the standards of the particular genre s/he has mastered.

References

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