Example of a Rubric and its use for improvement

Example Rubric for Scientific Experiment in Biology Capstone Course
by Virginia Johnson Anderson, Towson University
(From Walvoord and Anderson, Effective Grading: A Tool for Learning and Assessment, 1998, pp. 197-201)

Task Assignment: Semester-long assignment to design an original experiment, carry it out, and write it up in scientific report format. Students are to determine which of two brands of a commercial product (e.g. two brands of popcorn) are "best." They must base their judgment on at least four experimental factors (e.g. "% of kernels popped" is an experimental factor. Price is not, because it is written on the package).

	5	4	3	2	1
Title	Is appropriate in tone and structure to science journal; contains necessary descriptors, brand names, and allows reader to anticipate design.	Is appropriate in tone and structure to science journal; most descriptors present; identifies function of experimentation, suggests design, but lacks brand names.	Identifies function, brand name, but does not allow reader to anticipate design.	Identifies function or brand name, but not both; lacks design information or is misleading	Is patterned after another discipline or missing.
Introduction	Clearly identifies the purpose of the research; identifies interested audiences(s); adopts an appropriate tone.	Clearly identifies the purpose of the research; identifies interested audience(s).	Clearly identifies the purpose of the research.	Purpose present in Introduction, but must be identified by reader.	Fails to identify the purpose of the research.
Scientific Format Demands	All material placed in the correct sections; organized logically within each section; runs parallel among different sections.	All material placed in correct sections; organized logically within sections, but may lack parallelism among sections.	Material place is right sections but not well organized within the sections; disregards parallelism.	Some materials are placed in the wrong sections or are not adequately organized wherever they are placed.	Material placed in wrong sections or not sectioned; poorly organized wherever placed.
Materials and Methods Section	Contains effective, quantifiable, concisely-organized information that allows the experiment to be replicated; is written so that all information inherent to the document can be related back to this section; identifies sources of all data to be collected; identifies sequential information in an appropriate chronology; does not contain unnecessary, wordy descriptions of procedures.	As 5, but contains unnecessary information, and/or wordy descriptions within the section.	Presents an experiment that is definitely replicable; all information in document may be related to this section; however, fails to identify some sources of data and/or presents sequential information in a disorganized, difficult pattern.	Presents an experiment that is marginally replicable; parts of the basic design must be inferred by the reader; procedures not quantitatively described; some information in Results or Conclusions cannot be anticipated by reading the Methods and Materials section.	Describes the experiment so poorly or in such a nonscientific way that is cannot be replicated.
Non-experimental Information	Student researches and includes price and other non-experimental information that would be expected to be significant to the audience in determining the better product, or specifically states non-experimental factors excluded by design; interjects these at appropriate positions in text and/or develops a weighted rating scale; integrates non-experimental information in the Conclusions.	Student acts as above, but is somewhat less effective in developing the significance of the non-experimental information.	Student introduces price and other non-experimental information, but does not integrate them into Conclusions.	Student researches and includes price effectively; does not include or specifically exclude other non-experimental information.	Student considers price and/or other non-experimental variables as research variables; fails to identify the significance of these factors to the research.
Designing an Experiment	Student selects experimental factors that are appropriate to the research purpose and audience; measures adequate aspects of these selected factors; establishes discrete subgroups for which data significance may vary; student demonstrates an ability to eliminate bias from the design and bias-ridden statements from the research; student selects appropriate sample size, equivalent groups, and statistics; student designs a superior experiment.	As 5, but student designs an adequate experiment.	Student selects experimental factors that are appropriate to the research purpose and audience; measures adequate aspects of these selected factors; establishes discrete subgroups for which data significance may vary; research is weakened by bias OR by sample size of less than 10.	As 3, but research is weakened by bias AND inappropriate sample size	Student designs a poor experiment.

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	5	4	3	2	1
Defining Operationally	Student constructs a stated comprehensive operational definition and well-developed specific operational definitions.	Student constructs an implied comprehensive operational definition and well-developed specific operational definitions.	Student constructs an implied comprehensive operational definition (possible less clear) and some specific operational definitions.	Student constructs specific operational definitions, but fails to construct a comprehensive definition.	Student lacks understanding of operation definition.
Controlling Variables	Student demonstrates, by written statement, the ability to control variables by experimental control and by randomization; student makes reference to, or implies, factors to be disregarded by reference to pilot or experience; superior overall control of variables.	As 5, but student demonstrates an adequate control of variables.	Student demonstrates the ability to control important variables experimentally; Methods and Materials section does not indicate knowledge of randomization and/or selected disregard of variables.	Student demonstrates the ability to control some, but not all, of the important variables experimentally.	Student demonstrates a lack of understanding about controlling variables.
Collecting Data and Communicating Results	Student selects quantifiable experimental factors and/or defines and establishes quantitative units of comparison; measures the quantifiable factors and/or units in appropriate quantities or intervals; student selects appropriate statistical information to be utilized in the results; when effective, student displays results in graphs with correctly labeled axes; data are presented to the reader in text as well as graphic forms; tables or graphs have self-contained headings.	As 5, but the student did not prepare self-contained headings for tables or graphs.	As 4, but data reported in graphs or tables contain materials that are irrelevant. and/or not statistically appropriate.	Student selects quantifiable experimental factors and/or defines and establishes quantitative units of comparison; fails to select appropriate quantities or intervals and/or fails to display information graphically when appropriate.	Student does not select, collect, and/or communicate quantifiable results.
Interpreting Data: Drawing Conclusions/Implications	Student summarizes the purpose and findings of the research; student draws inferences that are consistent with the data and scientific reasoning and relates these to interested audiences; student explains expected results and offers explanations and/or suggestions for further research for unexpected results; student presents data honestly, distinguishes between fact and implication, and avoids over-generalizing; student organizes non-experimental information to support conclusion; student accepts or rejects the hypothesis.	As 5, but student does not accept or reject the hypothesis.	As 4, but the student over-generalizes and/or fails to organize non-experimental information to support conclusions.	Student summarizes the purpose and findings of the research; student explains expected results, but ignores unexpected results.	Student may or may not summarize the results, but fails to interpret their significance to interested audiences.

Applying this rubric to student capstone course work resulted in scores showed a need for improvement in the *Design of Experiments* and in *Defining Operationally*.

Student Scores for Science Reports Before and After Anderson Made Pedagogical Changes
(From Walvoord and Anderson, Effective Grading: A Tool for Learning and Assessment, 1998, p. 147)

Trait	**Before**	**After**
Title	2.95	3.22
Introduction	3.18	3.64
Scientific Format	3.09	3.32
Methods and Materials	3.00	3.55
Non-Experimental Info	3.18	3.50
Designing the Experiment	**2.68**	**3.32**
Defining Operationally	**2.68**	**3.50**
Controlling Variables	2.73	3.18
Collecting Data	2.86	3.36
Interpreting Data	2.90	3.59
Overall	*2.93*	*3.42*

After improving the course material an improvement was seen in the following year application of the rubric.