Squeezing Research into the Junior Physics Lab

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Abstract:

In my Junior Physics laboratory course I give the students an odd real-world problem to solve. It must be something 'off the wall' so that the solution can't be found on the internet. They must design the research and work in groups where each group completes part of the work. Each week they meet to decide what work must be done next by the following group. I feel this mimics real world research in industry and forces teamwork and planning. After this project I have the students choose a project of their own to work on. They prepare a powerpoint presentation of this research for their final exam. Often this research can be polished and expanded into a project that can be presented at research symposiums. Student reaction to this new way of 'doing lab' by doing research is positive. Many of our students are first generation college students who know very little about research. They seem more at ease when it comes to applying for REU's after doing some research.

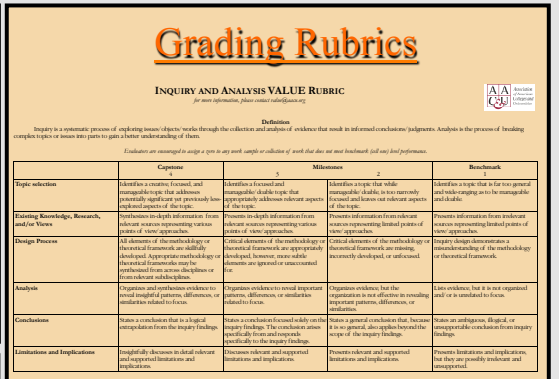
Why Research in Lab?

When the department revised our assessment plan we looked at what skills AIP thought was important for physics graduates to acquire. We decided teamwork, communication and lab design were going to be assessed in the Jr. Lab final project and in a project the student chose to do. Student lab reports had already been assessed using the lab and teamwork rubric to prepare them for the big project.

Assigned and Free Project

1. You are hired to do some consulting work for a new doggie bungee jumping business called *Woof-Woof Bungee*. You are to do research on the bungee cords supplied. The owner flunked physics and needs you to tell him the force constant(s) of the bungee cords (he heard they may not be uniform over varying ranges), to suggest which cords may be used with what weight ranges of dogs, the height of the bridge the dog must jump and the distance the cord stretches for these ranges of weights of dogs since some dogs are heavy and tall, others are light and tall. Animal rights people will shut down the business if dogs are injured. So you are to simulate a one and two bungee cord harness using weights instead of dogs. Since dogs go blind for forces over 2.5 g's, you must ensure that the jumps create 2.5 g's or less. He also is interested in the damping time of the jump so he can decide how much to charge and how many dogs he can jump in so many minutes. So find the time for the oscillation to damp for each weight of dog.
2. Students then chose a research project of their own.

Grading Rubrics



INQUIRY AND ANALYSIS VALUE RUBRIC

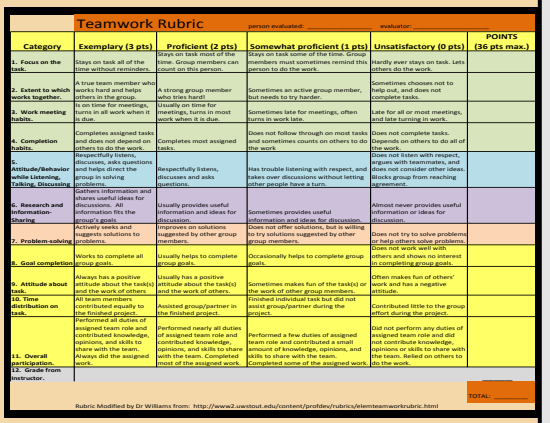
for more information, please contact value@aacu.org

Definition

Inquiry is a systematic process of exploring issues/objects/works through the collection and analysis of evidence that result in informed conclusions/judgments. Analysis is the process of breaking complex topics or issues into parts to gain a better understanding of them.

Evaluators are encouraged to assign a zero to any work sample or collection of work that does not meet benchmark (cell one) level performance.

	Capstone 4	Milestones 3	Milestones 2	Benchmark 1
Topic selection	Identifies a creative, focused, and manageable topic that addresses potentially significant yet previously less explored aspects of the topic.	Identifies a focused and manageable/doable topic that appropriately addresses relevant aspects of the topic.	Identifies a topic that while manageable/doable, is too narrowly focused and leaves out relevant aspects of the topic.	Identifies a topic that is far too general and wide-ranging as to be manageable and doable.
Existing Knowledge, Research, and/or Views	Synthesizes in-depth information from relevant sources representing various points of view/approaches.	Presents in-depth information from relevant sources representing various points of view/approaches.	Presents information from relevant sources representing limited points of view/approaches.	Presents information from irrelevant sources representing limited points of view/approaches.
Design Process	All elements of the methodology or theoretical framework are skillfully developed. Appropriate methodology or theoretical frameworks may be synthesized from across disciplines or from relevant subdisciplines.	Critical elements of the methodology or theoretical framework are appropriately developed, however, more subtle elements are ignored or unaccounted for.	Critical elements of the methodology or theoretical framework are missing, incorrectly developed, or unfocused.	Inquiry design demonstrates a misunderstanding of the methodology or theoretical framework.
Analysis	Organizes and synthesizes evidence to reveal insightful patterns, differences, or similarities related to focus.	Organizes evidence to reveal important patterns, differences, or similarities related to focus.	Organizes evidence, but the organization is not effective in revealing important patterns, differences, or similarities.	Lists evidence, but it is not organized and/or is unrelated to focus.
Conclusions	States a conclusion that is a logical extrapolation from the inquiry findings.	States a conclusion focused solely on the inquiry findings. The conclusion arises specifically from and responds specifically to the inquiry findings.	States a general conclusion that, because it is so general, also applies beyond the scope of the inquiry findings.	States an ambiguous, illogical, or unsupportable conclusion from inquiry findings.
Limitations and Implications	Insightfully discusses in detail relevant and supported limitations and implications.	Discusses relevant and supported limitations and implications.	Presents relevant and supported limitations and implications.	Presents limitations and implications, but they are possibly irrelevant and unsupported.



Teamwork Rubric — person evaluated: _____ evaluator: _____

Category	Exemplary (3 pts)	Proficient (2 pts)	Somewhat proficient (1 pts)	Unsatisfactory (0 pts)	POINTS (36 pts max.)
1. Focus on the task.	Stays on task all of the time without reminders.	Stays on task most of the time. Group members can count on this person.	Stays on task some of the time. Group members must sometimes remind this person to do the work.	Hardly ever stays on task. Lets others do the work.	
2. Extent to which works together.	A true team member who works hard and helps others in the group.	A strong group member who tries hard!	Sometimes an active group member, but needs to try harder.	Sometimes chooses not to help out, and does not complete tasks.	
3. Work meeting habits.	Is on time for meetings, turns in all work when it is due.	Usually on time for meetings, turns in most work when it is due.	Sometimes late for meetings, often turns in work late.	Late for all or most meetings, and late turning in work.	
4. Completion habits.	Completes assigned tasks and does not depend on others to do the work.	Completes most assigned tasks.	Does not follow through on most tasks and sometimes counts on others to do the work	Does not complete tasks. Depends on others to do all of the work.	
5. Attitude/Behavior while Listening, Talking, Discussing	Respectfully listens, discusses, asks questions and helps direct the group in solving problems.	Respectfully listens, discusses and asks questions.	Has trouble listening with respect, and takes over discussions without letting other people have a turn.	Does not listen with respect, argues with teammates, and does not consider other ideas. Blocks group from reaching agreement.	
6. Research and Information-Sharing	Gathers information and shares useful ideas for discussions. All information fits the group's goals	Usually provides useful information and ideas for discussion.	Sometimes provides useful information and ideas for discussion.	Almost never provides useful information or ideas for discussion.	
7. Problem-solving	Actively seeks and suggests solutions to problems.	Improves on solutions suggested by other group members.	Does not offer solutions, but is willing to try solutions suggested by other group members.	Does not try to solve problems or help others solve problems.	
8. Goal completion	Works to complete all group goals.	Usually helps to complete group goals.	Occasionally helps to complete group goals.	Does not work well with others and shows no interest in completing group goals.	
9. Attitude about task.	Always has a positive attitude about the task(s) and the work of others	Usually has a positive attitude about the task(s) and the work of others.	Sometimes makes fun of the task(s) or the work of other group members.	Often makes fun of others' work and has a negative attitude.	
10. Time distribution on task.	All team members contributed equally to the finished project.	Assisted group/partner in the finished project.	Finished individual task but did not assist group/partner during the project.	Contributed little to the group effort during the project.	
11. Overall participation.	Performed all duties of assigned team role and contributed knowledge, opinions, and skills to share with the team. Always did the assigned work.	Performed nearly all duties of assigned team role and contributed knowledge, opinions, and skills to share with the team. Completed most of the assigned work.	Performed a few duties of assigned team role and contributed a small amount of knowledge, opinions, and skills to share with the team. Completed some of the assigned work.	Did not perform any duties of assigned team role and did not contribute knowledge, opinions or skills to share with the team. Relied on others to do the work.	
12. Grade from instructor:					TOTAL: _____

Rubric Modified by Dr Williams from: http://www2.uwstout.edu/content/profdev/rubrics/elemteamworkrubric.html

JUNIOR LAB PEER GRADING SHEETS SP2014 - DO NOT GRADE YOURSELF. .

	Strongly Agree	Agree	Disagree	Strongly Disagree	Not Apply	SUM
	5	4	2	1	3	xxxxxxx
Can hear presentation						
Can see presentation						
Paper given professionally						
Explained well						
Research Complete						
Work Shared						
Overall Pt Score						

References:

1. http://aip.org/statistics/physics-trends/skills-used-regularly
2. http://www2.uwstout.edu/content/profdev/rubrics/elemteamworkrubric.html
3. http://bloomu.edu/documents/middlestates/monitoringreport/MSRpt/E_26.pdf
4. Williams, K. (2007). Junior Physics Laboratory Manual, 2nd Ed., East Central University Publishing.