Rubric Items for Student Evaluation in CHEM 300: Chemistry Research
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(1) Improvement in Understanding of Relevant Concepts and Material
Description: In some ways, this is the simplest and most obvious area. Everyone comes with different backgrounds and amounts of experience with chemistry concepts relevant to the research you will each be performing. Success in this area will rely on pushing yourself to understand your project (and the projects of others in the group) and place it in a larger chemical context. As you progress, you will become more adept at proposing solutions to difficulties we encounter and will become increasingly capable of drawing on the relevant chemical literature to do so. It has been well demonstrated that learning to explain concepts to others can increase your own comfort with them, so this area also encompasses your ability to help others understand chemical concepts.

(2) Critical Thinking and Problem Solving
Description: The nature of cutting-edge research dictates that we will frequently encounter problems for which the answer is not readily apparent. Effective problem solvers will relish the challenge provided by new problems and will bring all of their skills (from Chemistry courses and other experience) to seek "out of the box" solutions, draw on a variety of resources, and seek to incorporate diverse techniques. Evaluation in this area will necessarily focus on process as well as outcomes.

(3) Teamwork
Description: Modern science is quite unlike the stereotypical image of the lone investigator working at a desk or lab bench. Scientific research is dynamic and collaborative, with many of the most important modern problems tackled by teams of researchers. Effective team members are those who:

- Pitch in regularly to help with tasks in the lab that may not directly relate to their projects
- Are considerate of others and attempt to understand and contribute to others' projects
- Are good listeners
- Work to ensure a physically and intellectually safe environment for everyone, while also being willing to challenge assumptions and provide constructive criticism respectfully

Evaluation in this area will be based on my observations and those of other group members as well as your own reflections.

(4) Resilience: Identifying and Responding to Failures and Setbacks
Description: One of the wonderful and yet often frustrating things about scientific research is that failure is always part of the process. There's no way around it. Fortunately, we can train ourselves to identify setbacks and respond constructively, and this set of skills is critical in many aspects of life, not only in the laboratory. Evaluation in this area will focus both on your ability to assess how things are going in a rational way and to respond productively to failures and setbacks. As team members, I expect that we will all help each other work through frustrations and failed experiments as we move our research forward.

(5) Metacognition and Self-Assessment
Description: Successful growth in any area requires the ability to understand your strengths and limitations as well as identifying and critically assessing your thought processes. Only after taking stock of these things through dedicated reflection can you decide where and how to spend your time to ensure optimal progress. This course will provide several structured opportunities for self-reflection, primarily around the items in this rubric, with the goal that you will gain an enhanced appreciation of your strengths and increased ability to identify areas and strategies for improvement.

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Evaluation of Rubric Items

Each of the rubric items will be evaluated on a scale of 1–4, corresponding roughly to three categories:

- Benchmark (1): Meeting baseline expectations
- Milestones (2–3): Progressing beyond baseline in significant ways
- Capstone (4): Outstanding performance

'Capstone' evaluation in an area encompasses much more than simply working hard; it indicates going beyond expectations and demonstrating proficiency. In the following pages, I provide more thorough explanations of the scale in the context of each rubric item. Note that some have much more detail than others, but hopefully these will give you an idea of the behaviors and habits of mind I hope to see develop.

Learn more about the AAC&U VALUE Project:

Association of American Colleges and Universities. (2009). *Valid Assessment of Learning in Undergraduate Education (VALUE).* https://www.aacu.org/initiatives/value

Improvement in Understanding of Relevant Concepts Rubric

	Capstone (4)	Milestones (2–3)	Benchmark (1)
Use of literature and electronic resources	• Takes ownership of the learning process and recognizes that every resource (assigned or found) can point toward directions for further learning • Uses the literature to draw connections between areas that are understood and areas that are less clear, developing a map of new and old concepts that interrelates them and suggests areas for further growth.	• Uses assigned and suggested readings as starting points, frequently searching the literature for additional resources that can provide more information or alternate viewpoints. • Uses parts of readings that are unclear in order to identify broader concepts and attempts to clarify how these fit into the bigger picture.	• Reads assigned pieces in order to better understand material. • Identifies parts of readings that are unclear and formulates questions
Interaction with others	• Actively seeks others (within or outside group) who can serve as appropriate resources for increasing knowledge and asks well-structured questions to learn from them. • Seizes opportunities (large or small) to explain to others and recognizes that such opportunities can also increase own understanding	• Identifies others within the group when questions arise; happy to learn from others • Attentive to others' explanations of projects and their questions, allowing them to interact with others' learning processes • Happy to explain techniques or concepts to others, but may not view such situations as personal learning opportunities	• Willing to ask questions of others and the PI; may have trouble identifying the best resource or be reluctant to use some available personnel resources • Listens carefully to others' explanations of projects and concepts in group meeting, asking questions when appropriate.
Synthesis and application of knowledge	• Identifies how new knowledge (learned both from reading and experiments) overlaps with previous knowledge; works to create a holistic model that ties together new and old knowledge • Eager to apply new understandings to existing problems or identify other unresolved areas for future experiments; uses new learning to find other areas of deficient understanding to explore by searching literature and questioning others	• Articulates new learning and attempts to situate it with other knowledge, mostly close in field; willing to adjust previous views in light of new learning and evidence. • New understandings are viewed both as solutions to old problems and suggestions for new areas of work, but the leap to taking on new work (reading or experiment) is not yet done independently.	• Understands and articulates new learning, but may not be able to situate it with what was understood before or be able to adopt previous views to fit new evidence. • New understandings are used to understand the problems for which they were sought out, but not applied in new ways.

Critical Thinking and Problem Solving Rubric

	Capstone (4)	Milestones (2–3)	Benchmark (1)
Explanation of Issues	• Issues/problems are stated clearly and described comprehensively, delivering all relevant information necessary for full understanding	• Issues/problems are stated but description may leave ambiguities unexplored, boundaries undetermined, and/or backgrounds unknown	• Issues/problems are stated without clarification or description
Use of Evidence	• Information is taken from appropriate variety of sources with enough interpretation and evaluation to develop a comprehensive analysis and synthesis. • Viewpoints of experts are questioned thoroughly.	• Information is taken from sources with some interpretation/evaluation (2) and some progress toward analysis and synthesis is made (3). • Viewpoints of experts are taken mostly as fact, but subject to some questioning.	• Information is taken from source(s) without any interpretation/evaluation. • Viewpoints of experts are taken as fact, without question.
Influence of context and assumptions	• Thoroughly analyzes own and others' assumptions	• Identifies and questions some of own and others' assumptions and shows some awareness of the importance of context on interpretations and assumptions.	• Shows an emerging awareness of present assumptions.
Hypotheses, Models, and Conclusions	• Specific proposals are imaginative, acknowledge possible limits, and synthesize the views of others, as appropriate. • Findings are used to develop further testable hypotheses that can advance the project.	• Specific proposals take several lines of evidence into account and acknowledge relevant complexities. • Conclusions/findings tend to be extrapolated narrowly to the system of interest. Further testable hypotheses may be developed, but these are often more limited in scope.	• Specific proposals are stated, but may be simplistic or obvious. • Findings are understood but not extrapolated to further studies.

Teamwork Rubric

	Capstone (4)	Milestones (2–3)	Benchmark (1)
Contribution to Group Meetings	• Shows awareness of how many projects fit together and uses findings from others' projects to propose new solutions • Helps the team move forward by articulating the merits of alternative ideas or proposals and relating to the literature • Engages team members in ways that facilitate their contributions by both building upon or synthesizing contributions of others as well as noticing when someone is not participating and inviting them to engage	• Asks insightful questions that lead to greater group understanding • Shows awareness of others' projects and their advances/struggles • Offers ideas to advance the work of the group (2), which may build on the work of others (3) • Engages team members in ways that facilitate their contributions to the group by restating or asking clarifying questions (2) or building upon and synthesizing others' contributions (3)	• Attends group meetings and labs • Prepares for meetings by reading in advance • Attentive and respectful during others' presentations and questions • Takes turns in speaking/listening • Asks clarifying questions when confused • Shares ideas but they may be more related to their own project than others'
Lab Work	• Completes assigned tasks with excellence and ahead of schedule when possible • Proactively helps other team members complete their tasks with excellence • Notices tasks that can be done to support team goals in the lab and takes the lead in ensuring they get done • Actively helps the lab to maintain a productive, safe environment, both in their project and in others'	• Completes assigned tasks on time and assists others with their tasks when asked • Uses time in lab to accomplish needed work that supports the group in addition to tasks related to own work • Follows safety protocols carefully, actively thinks about how to make the lab safer, and helps instruct others when asked	• Shows up on time and works at agreed upon level every week • Completes assigned tasks by deadline • Respectful of others' space, equipment, experiments • Answers questions that others have • Follows safety rules and protocols, asking questions if unsure about safety

Support and Mentoring	• Supports a constructive team climate by doing all of the following:
	  o Treats team members respectfully by being polite and constructive in communication
	  o Uses positive vocal or written tone, facial expressions, and/or body language to convey a positive attitude
	  o Motivates teammates by expressing confidence about the importance of the task and their ability to accomplish it
	  o Provides assistance and/or encouragement to team members
	• Seeks opportunities to engage other team members on areas of common interest
	• Looks for chances to teach and support others in their projects and find areas of overlapping research/interests with other members
		• Supports a constructive team climate by doing more than one of the following:
		  o Treats team members respectfully by being polite and constructive in communication
		  o Uses positive vocal or written tone, facial expressions, and/or body language to convey a positive attitude
		  o Motivates teammates by expressing confidence about the importance of the task and their ability to accomplish it
		  o Provides assistance and/or encouragement to team members
		• Happily accepts opportunities to teach others and discuss projects, including offering suggestions
			• Supports a constructive team climate by doing any one of the following:
			  o Treats team members respectfully by being polite and constructive in communication
			  o Uses positive vocal or written tone, facial expressions, and/or body language to convey a positive attitude
			  o Motivates teammates by expressing confidence about the importance of the task and their ability to accomplish it
			  o Provides assistance and/or encouragement to team members

Resilience Rubric

	Capstone (4)	Milestones (2–3)	Benchmark (1)
Identifying and responding to personal setbacks	• Critical mindset allowing frequent identification of possible issues and assessment of the best course (neither giving up too easily nor refusing to acknowledge failure and persisting for too long), accompanied by a strong sense of optimism and perseverance that allows the researcher to rebound quickly from setbacks.	• Persistent in pursuing experimental results yet open-minded about possible failures • May show some tendency to acknowledge failure too readily and abandon certain experiments or approaches too early _or_ may exhibit a tendency to stick with experiments for too long in spite of repeated signs that a different approach is needed; in either case, a positive attitude is maintained.	• Openness to input and willingness to analyze experimental outcomes thoughtfully and honestly, but may need significant guidance through the process of identifying and responding to setbacks/failures _or_ may routinely struggle to rebound from setbacks in lab.
Supportive lab environment	• Aware of others' experiments and goals; helps them critically analyze experiments at a high level and routinely offers appropriate support/advice when failures are encountered.	• Shows some awareness of others' projects and the successes and failures associated with them offers some support/advice, but may struggle to be aware of the difficulties others in the lab face.	• Encouraging and empathetic team member; may be a bit too wrapped up in own project and its successes or failures to fully engage in supporting others, but dedicated to being a strong contributor and support for others.

Metacognition and Self-Assessment Rubric

	Capstone (4)	Milestones (2–3)	Benchmark (1)
Understanding thought processes and strategy	• Excellent understanding of mental models and strategies used on any particular problem and their shortcomings. • Meaningfully synthesizes connections among different experiences and/or areas of learning and uses them to articulate processes and strategy. • Recognizes and actively seeks alternate strategies and points of view when appropriate.	• Actively considers the approach(es) used when addressing new problems and articulates some of the strengths and weaknesses inherent in the approach(es). • Seeks alternative strategies but may tend to get stuck in particular ways of thinking or struggle to synthesize the approach with other experiences and/or areas of learning.	• Recognizes and appreciates that there are multiple approaches to solving any problem • May tend to struggle to find alternatives and recognize assumptions.
Self-reflection: Identifying strengths and weaknesses	• Reflections, both written and in person, show high self-awareness and recognition of strengths and areas for growth. • Reflections take into account all areas of the rubric and recognize both the personal and situational (project and team) factors leading to observed behaviors. • Areas of strength are encouraged and sustained; areas for growth are actively targeted and become items for special focus	• Reflections show good self-awareness, but may be less aware of either strengths or areas for improvement. • Reflections may overemphasize either personal or situational factors related to a particular outcome or behavior. • Plans are made for growth in weak areas or leveraging strengths, but one of the two may be underemphasized.	• Reflections attempt to address all of the rubric areas and show intentionality and honesty in assessing these areas; all strengths and weaknesses might not be accurately recognized but some of each are always identified; the interplay of personal and situational factors may not be recognized.