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# Equitable and strategic recruitment and selection of undergraduates for research opportunities in labs

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**Synopsis and scope of this document:** In this document we take a closer look at conditions in our own pipeline of undergraduate research opportunities. We first introduce the importance of our role and duty in hiring undergraduates equitably for solving deeper-rooted problems in the academic pipeline. The topics covered in this document are non-exhaustive in relation to DEI practices and carry with them important assumptions regarding intent. Mentors are assumed to have an innate willingness to try to improve equitable access to undergraduate research (an *a priori* goodwill). The goal of this document is to bring attention to certain conditions that relate to inequity and provide future guidance for better practices. Note that this document is non-exhaustive, and only manages to cover a few important parts of the undergraduate research opportunity pipeline. Topics not covered are equally important and should be further investigated.

**Intended audience:** This report was written for faculty or anyone who might serve as mentor to an undergraduate student in a research setting.

**Important definitions:** Perhaps need not be said, but this report relates mainly to finding equitable practices *not* equal practices. Equal practices are not necessarily equitable. Equitable practices *operate proactively* address systemic problems. We define an equitable opportunity as one that allows everyone to succeed irrespective of their identity (e.g., racial, gender, cultural) or factors that lie beyond their immediate control (e.g., family income, parenting).

**Quick numbers:** Undergraduate research in UW ChemE at a glance. Additional Q&A for data collected by Nicole Minkoff can be found in **Appendix A**.

- ◊ **Overall undergraduate research engagement**
  - 70% of seniors had at least one research experience [Pre-pandemic]
  - 50% of seniors had at least one research experience [Post-pandemic]
- ◊ **Transfer student engagement**
  - 11 transfer students involved in research (16% of senior class)
  - 40% of transfer students involved in research

**Topics covered in this report:**

1. Advertising opportunities
2. Models for mentorship
3. Grading and evaluating undergraduate research

**Topics not covered (topic for future report):**

1. Equitable practices for conducting an interview for undergraduate research
2. Equitable practices for selecting candidates
3. Preparing graduate students to be mentors for undergraduates
4. Addressing equity for transfer student research experiences
5. Equity and compensation in undergraduate research
6. Research opportunities for work-study students
7. Research opportunities for non-traditional students

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8. Resources available at UW for undergraduate research experiences
9. Deep dive into best practices for graduate admissions rubric

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## Introduction: Why you should care

**Fixing a leaky pipe.** Fixing systemic underrepresentation of racial minorities and traditionally marginalized groups in research settings. The pipeline to research careers (academic or industry) begins with undergraduate research experience. Early involvement in research projects shapes student conceptions about research careers and provides critical training required to succeed. In a review examining racially equitable admissions practices in STEM doctoral programs (Roberts 2021), it was found that undergraduate research experiences play a pivotal role in pursuit of postbac degrees, especially for physics graduates. Notably, 30% of recent physics graduates from underrepresented backgrounds who expressed initial interest in pursuing a PhD eventually opted out, attributing their decision to a lack of research experience. It is important to realize that graduate research program admission tends to be gated by undergraduate research experiences, especially at top programs.

**Practicing what we, and others, preach.** Our own graduate PhD program admissions rubric places high value on undergraduate research experiences. Research experience accounts for 4 of 16 possible points used in admissions (Table 1). In our 2023 admission cycle, none of the admitted students scored a 1, while most scored either 3 or 4 in the research category. Access to research opportunities is one general source where stratification happens. In our own efforts to address this, our rubric includes points that can be awarded for other factors that we believe indicate research aptitude. Equitable graduate admission rubric design is beyond the scope of this report but can be the subject of future discussion. Additional examples of graduate rubrics can be found in **Appendix B**.

**Prior research experience is rewarded in admissions.** Though we pride ourselves in using a rubric that attempts to address equity, we should realize that not every admission or hiring committee will do the same. Since the incentive structure for admissions tends to use prior research as a measures of research aptitude, prior research experience will always be rewarded in the graduate admissions process. As a long-term consequence, research experience is often a gate towards graduate degrees which further increase future inequality. Students graduating with PhDs in engineering will earn more over their lifetime and are more likely to be in management/leadership roles compared to students who did not pursue graduate degrees. Equitable practices for creating research opportunities for our own students help create future career options that have higher mobility, higher wages, and tend to management/leadership roles.

***Table 1.*** *Research related rubric items for UW ChemE 16-point graduate admissions rubric for PhD program. In our rubric, up to 2 points can be awarded as a wiggle-factor to partially address equitable research opportunity access. Though other measures of aptitude can also be found in graduate admissions rubrics, research experience will always present as a factor. Full rubric (with all other criteria) can be found in* ***Appendix B****.*

| Points | Criteria |
|---|---|
| 4 | First-author on a research manuscript, national conference presentations, awards, outstanding service in leadership role in ChemE-related groups |
| 3 | Co-author on a manuscript, local research presentations, some awards, some leadership in ChemE-related groups |

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| | |
|---|---|
| 2 | Applicant has demonstrated commitment to a research lab as an undergrad for >1 year, involved in ChemE-related groups |
| 1 | Limited to no research experience, <1 year experience in a group (or in combination within several groups) |

**Wiggle Factor (Up to +2 points)**

Possible values = 0, 1, 2. Many (if not most) applicants will receive a 0 here. Some examples of reasons to award points include:

- Exceptionally strong overlap/fit with many ChemE faculty research areas
- Champion of diversity
- Personally faced and overcame unique challenges to get to where they are
- Personal reason to be in the PNW (family, etc)

**A duty to the public.** As a public institution, we are inherently bound by a commitment to serve the broader community and uphold the values of accessibility, inclusivity, and equity. Providing opportunities for research-based careers is not merely an academic endeavor but should be part of our own obligation. By creating opportunities for undergraduate students to pursue research roles we are fulfilling our mandate to the public. Undergraduate research experiences serve a larger purpose than just preparing students for graduate school.

**Preparing students for academia and industry.** Research opportunities prepares students for both academic and non-academic careers. These transferrable skills are precisely what many industries seek, especially in an era dominated by innovation and data-driven decision-making. Students with a research background often find themselves more competitive in the job market, standing out as candidates who can seamlessly transition from academic settings to meet real world challenges.

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## Section 1. Finding research opportunities

**Overview.** Students can become involved with research opportunities through a variety of means. Successful opportunities necessarily require a willing trainee and recipient mentor. As a recipient mentor or lab, is important to carefully consider how opportunities are offered to students. Equitable practices in advertising positions ensure that opportunities are accessible to all students, regardless of their background or network. To promote inclusivity, positions should be posted on public platforms, including those specifically catering to underrepresented groups in the academic field. Transparency about the requirements, responsibilities, and benefits of the position is crucial. Additionally, avoiding jargon and using clear, inclusive language will help in reaching a broader audience. Engaging in these practices not only promotes fairness but also ensures that labs benefit from a wide range of perspectives and talents.

Below are just a few ways that the connection between a willing mentee and a willing mentor could be created.

***Table 2.*** *Brief break down of how students find research opportunities.*

| | Opportunity | Short description | Equal | Equitable |
|---|---|---|---|---|
| **A** | Cold-email (Student initiated) | Direct mentorship on a mentor-initiated project, supervised by mentor with feedback and training. | Yes | No |
| **B** | Recommendation from colleague | You are referred a student | No | Maybe |
| **C** | Class recruitment | Recruit top performing students from a class to your research group. | Yes | No |
| **D** | Department advertisement | Student initiated project where area mentor serves an advisory role outside area of expertise. | Yes | Yes* |
| **E** | School advertisement | Student and mentor create a new line of inquiry based on mutual interest. | Yes | Yes* |
| **F** | Advertisement to undergraduate student groups | Targeted advertisement about open research opportunities to affinity groups on campus. | No | Yes* |

**Recommendations:** In this short sub-section, I detail some of the rationale behind why some of these options are often pursued for advertisement/recruitment and why we should rethink their implementation. How merit, aptitude, and mentor personal incentives align with equality and equity are pointed out. As a general recommendation, best practices would involve having open searches similar to those implemented by the state for fair and equitable hiring practices (Options DE+F).

**Option A:** Cold emailing to find research is common and encouraged by most departments on school and campus. The idea that the most motivated students should do research (merit) aligns with the incentive mentors might have. Email is freely accessible, and any student has access to this opportunity (equal). This option is also little effort, which could see fast turnaround if students are available at the right time. However, this practice is not equitable. Though more recent studies likely exist, a 2009 study found that underrepresented and traditionally marginalized groups are less to contact faculty about research opportunities (Kim 2009). They are also less likely to ask for volunteer opportunities and more likely to ask for paid opportunities.

**Option B**: Endorsements from colleagues can provide insights into a student's capabilities and fit for a particular lab or project. For the mentor, receiving a recommendation from a trusted colleague can streamline the selection process, providing an assurance of the student's capabilities (aptitude, merit). On the surface, this practice seems to provide equal opportunity since any student can be recommended by a professor or instructor they have worked closely with. This requires minimal effort on the student's part and might result in swift placement within research projects. However, this method poses equity challenges. Not all students have equal opportunities to form close relationships with faculty or get involved in projects that might lead to such recommendations. For instance, students from underrepresented backgrounds or those who work part-time might have fewer chances to impress faculty compared to their peers. This underscores the importance of mentors being proactive and deliberate in diversifying their networks and sources of student recommendations.

**Option C:** Recruiting top-performing students from one's class to fill research positions is a common practice in many academic settings. This method might seem to reward merit, ensuring that students with the highest grades, and ostensibly, the most dedication or aptitude, are given research opportunities. From the mentor's perspective, this can seem like a logical and efficient way to source talented individuals, with the grade serving as a proxy for the student's capability. However, this approach can inadvertently perpetuate inequities. Not all students have equal access to resources and support systems that enable academic excellence. Factors such as financial challenges, family responsibilities, or lack of prior educational opportunities can impact a student's performance in class. Moreover, there are inherent biases in how traditional grading systems evaluate students, often disadvantaging those from diverse or underrepresented backgrounds. By primarily selecting top-performers based on grades alone, mentors might inadvertently exclude a wide array of talented students who bring different perspectives and strengths to research but may not have had the chance to excel in traditional academic metrics. It's crucial for mentors to recognize this and consider more holistic approaches to student recruitment.

**Option D/E + F [Recommendation]**: Posting general advertisements for research opportunities on school or departmental bulletin boards and websites is a widespread practice in academic environments. On the surface, this method appears to cast a wide net, providing all students who access these platforms with an equal opportunity to discover and apply for these positions. This approach is generally inclusive, transparent, and efficient while not aiming to attract any particular candidate. There are general caveats to this practice that one should consider. Students from marginalized or underrepresented backgrounds more often feel intimidated or believe they don't belong in research roles, even if they come across these ads. This can lead to a self-selection bias where only certain groups feel encouraged to apply. It's essential for mentors and departments to be aware of these limitations and consider additional outreach and recruitment strategies that actively engage diverse student populations.

A proactive remedy to address the limitations of general advertisements is to disseminate ads specifically targeted to various student groups, particularly those representing underrepresented or marginalized backgrounds. By directly reaching out to organizations or clubs that support minority students, first-generation college students, or other diverse groups, mentors can create a more inclusive recruitment strategy. This tailored approach not only broadens the pool of potential applicants but also sends a clear message of inclusion and intentionality, encouraging students who might otherwise self-select out of research opportunities to consider applying.

Additionally, using language in advertisements that specifically welcomes marginalized groups to apply can also help.

### Closing remarks on advertising student opportunities.

While fair advertisement of research opportunities is undeniably crucial in reaching a broad and diverse pool of applicants, having a fair interview and selection process is equally, if not more, vital in achieving true equity. Once applicants respond to an advertisement, the interview and selection processes become the gatekeepers to the opportunity. If these processes are biased, even unconsciously (such as those that prioritize merit rather than equity), they can perpetuate systemic inequities and negate the benefits of a diverse applicant pool. Ensuring that interviews are structured, questions are consistent across candidates, and evaluation criteria are clear and unbiased can make a significant difference. Though not covered in this report, a general recommendation would be to have mentors undergo training that cover unconscious bias training, candidate review rubrics, interview structure, fair hiring practices. As an example, programs like DYSS have student review panel undergo unconscious bias training (provided by the ADVANCE Center at UW).

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## Section 2. Models for undergraduate research experiences

**Overview.** The following section details models for introducing opportunities for undergraduate research. Description of models are from Temple, Sibley, & Orr (2010) and Multhaup, et al. (2010). The goal of this section is to showcase alternative models that exist. These are the types of tools we can deploy as a department to improve access to opportunities. Not all opportunities need to follow a traditional approach. Unlike in the previous section, no general recommendation is provided. Mentors should familiarize themselves with types of models that can be implemented and decide if the chosen model is the best for their mentee and project.

| | Model Name | Short description | Note |
|---|---|---|---|
| **A** | Apprenticeship | Direct mentorship on a mentor-initiated project, supervised by mentor with feedback and training. | Most common form of opportunity |
| **B** | Consultant | Student initiated project where area mentor serves an advisory role outside area of expertise. | Similar to an iGem or EWB experience |
| **C** | Joint Creation | Student and mentor create a new line of inquiry based on mutual interest. | Project area is undergraduate initiated |
| **D** | Research Teams | Students collaborate on a research project and work in teams. Relies heavily on peer mentorship. | Nance lab training model |
| **E** | Course Based | Course based research activity that is focused on answering a predefined research question. Answer to question is not known. | Similar to lab-based course but has students performing original research. Most similar to a capstone project. |
| **F** | Summer Research | Intensive summer research experience | REU or other summer opportunity |
| **G** | Senior Thesis | Course or non-course-based research experience with structured outcome (compulsory) | Similar to Princeton ChemE curriculum. |

***Table 3. Undergraduate research experience models.*** *Mentors can be any of the following: faculty, postdoctoral scholars, graduate students, or senior undergraduates.*

**Pros and Cons of research models.** Further elaboration on each type of opportunity and how it relates to the undergraduate student research experience. Pros and cons to consider for each one is then detailed.

**Option A. Apprenticeship or traditional undergraduate research experiences. [Hands On]**

Pros:

- ◊ Easy to implement.
- ◊ Can provide high quality research experience making student more competitive for future opportunities.
- ◊ Students benefit from building a close mentor-mentee relationship.

Cons:

- ◊ Requires a direct mentor for each undergrad and generally more time per mentor (difficulty scaling, time consuming)
- ◊ Sensitivity to mentor teaching philosophy (requires good mentor). Has risk of being exploitative in nature.
- ◊ May lack in having students obtain initiative or be creative. Scope might be too narrow for learning if projects not carefully designed.

**Option B. Mentor serving as a consultant to a student-initiated project. [Hands off]**

Pros:

- ◊ Allows students to explore their own ideas independently and create ownership over their project.
- ◊ Provides a training experience more conducive to critical thinking.
- ◊ Generally, more flexible of a model for the mentor, which means it will likely interfere less with possible.
- ◊ This form of independent training is more like a graduate student research experience, which might prepare mentees more for academic opportunities.

Cons:

- ◊ Depending on student preparedness to operate independently, could have opposite of intended effect and overwhelm, discourage students.
- ◊ Without proper oversight, has possibility of straying from a proper research path. Student failure in research projects, when given ownership, carries risk of making them feel like they could not succeed in a research environment.
- ◊ Limited feedback could slow down progress on a project.
- ◊ Less personal connection built with mentor if consultation time is limited.

**Option C. Joint-project creation between student and mentor (exists between Option A and B)**

Pros:

- ◊ Provides students a sense of ownership over project.
- ◊ Introduces students to collaborative science and collaborative research (rather than top-down models)
- ◊ Shares advantages with traditional hands-on model

Cons:

- ◊ Requires student initiative and alignment between mentee and mentor on vision.
- ◊ Potential to clash with direction research is taking, especially if both parties feel.
- ◊ Requires careful management to ensure that project is actively steered by mentor without alienating student and making them feel like they lost ownership of the project.
- ◊ Requires more personal investment from mentor, harder to implement.

**Option D. Student research teams with more senior undergraduates mentoring junior members. Research adviser serves in a consultation role to the project.**

Pros:

- ◊ Shares many of the same advantages as Option B (low time commitment, independence and ownership provided to mentee)
- ◊ Uses peer learning as the basis for training.
- ◊ Provides opportunities for undergraduate students to be research leaders and research mentors.
- ◊ Helps spread project workload between multiple students

Cons:

- ◊ Despite peer learning being effective, there is a knowledge ceiling that many groups might encounter compared to training provided by graduate, postdoc, or faculty member.
- ◊ Group dynamics might warrant conflict management stemming from interpersonal student relations, varying levels of commitment between students.

- ◊ Problems with coordination of students might arise that could dampen pace project could progress.
- ◊ Problems with ownership could arise early on, which could discourage students from wanting to pursue collaborative science in the future.

**Option E. Course based research experiences (CURE**).

Pros:

- ◊ Participation in course-based research improves outcome of students in lecture-based partner courses.
- ◊ Course-based research is typically structured with clear objectives and timelines, ensuring students understand expectations and outcomes.
- ◊ Is tied into the undergraduate education curriculum, ensuring that students are applying knowledge learned in other classes and reinforcing overall learning.
- ◊ Scalable and can be used to provide a large number of students collaborative research experience

Cons:

- ◊ Given the defined scope of the class, the depth of research might not be as deep as one might encounter in typical research lab.
- ◊ Less flexibility regarding the type of research question that is being pursued.
- ◊ Less autonomy over direction research might take.
- ◊

**Option F. Summer research experiences such as REU or UW-specific summer opportunities.**

Pros:

- ◊ Focused time to perform research without courses lets them engage in a way more like graduate research.
- ◊ Networking opportunities are often available for REU programs.
- ◊ Students develop skills.
- ◊ Honor/Award/Stipend usually accompanies these types of opportunities, which can help student competitiveness for future opportunities.

Cons:

- ◊ Since these can fall outside city where student is enrolled, or during a period where student does not have local access to housing, can be financially burdensome if not compenetrated.
- ◊ Limited number of opportunities available. Opportunities that do exist are very competitive.
- ◊ Short duration of these opportunities (10-12 weeks) limits the depth of research performed.
- ◊ Inherent opportunity cost – students engaging in

**Option G. Senior thesis that requires all students to engage with research (2-3 quarters) for their degree.**

a. Pros:

- ◊ Resolves problems with students graduating without having had the chance to engage with research.
- ◊ Maintains advantage structure to the type of opportunity from Options A, B, C

b. Cons:

- ◊ Scales poorly, and unlikely to work with our department due to student to lab ratio.

- ◊ Requires personal vestment from whole department.
- ◊ Could strain research lab resources. Costly to operate.
- ◊ Best suited for small ChemE program
- ◊ May not provide meaningful experiences to students who are not interested in research opportunities.

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## Section 3. Credit and grading undergraduate research experiences

**Overview:** The goal of this section is to discuss reasons for moving away from a max credit/max grade model for undergraduate research. If our goals is training future researchers (academic or industry), then training assessments will ultimately better serve our students. Proper assessment and accreditation of undergraduate research gives clear training goals and sets expectations. It more carefully considers what we should be accomplishing as mentors. Undergraduate students being trained for a career in research should emerge from the experience with more than just technical skills. In this section, we go over various facets that we should be assessing in undergraduate research training. An example grading rubric is then discussed and suggestions for tailoring are provided. Beyond what is covered in this section, an additional framework for grading undergraduate research is provided here.
*Note: We assume a traditional apprenticeship model in examples provided below.*

**Why use a rubric.** Even if you are philosophically opposed to not giving students maximum credit, providing rubrics for a research experience serve a greater purpose. Rubrics (as is implemented in our graduate admissions process) are the start of a holistic and equitable assessment process. Rubrics ensure **fairness**, as every student is judged based on consistent criteria, eliminating arbitrary or biased evaluations. This uniformity also brings about **transparency**, making it clear to students, mentors, and external observers how various aspects of the research process are being assessed. By clearly defining these criteria, the rubric **sets student expectations**, allowing them to understand precisely what is required in terms of effort, quality, and outcomes. Furthermore, this clarity inherently establishes a **path to success**, as students can align their efforts with the rubric's benchmarks, strategizing their approach for optimal outcomes. Lastly, such a rubric offers **structure** to the training experience. Students and mentors will both have a defined roadmap, ensuring that learning and development objectives are both systematic and comprehensive.

**Features we should assess undergraduate students on:**

A. Work Quality: Technical skills, carefulness and reproducibility, research initiative, results, consistency, record keeping, effort, time invested

B. Engagement: Attending meetings, engaging with others in a research group

C. Literature: Read and understand scientific literature, synthesize research questions, understand state of the field

D. Communications: Verbal communication skills, written communication skills, visual communication skills

**Making and tailoring a rubric.** Taking these assessment categories into consideration, we should suggest a grading rubric that weighs our own relative importance towards our assessment goals. An equal policy would have universal rubric, while an equitable one would have grading rubric tailored to individual mentees and their projects. As an example rubric that can be used as a starting point we will be working with an undergraduate research assessment rubric made by Marquita Landry's group at UC Berkeley, ChemE Department. Rubric categories will be discussed.

| | | Exemplary (90-100%) | Accomplished (80-89%) | Developing (70-79%) | Unsatisfactory* (0-69%) | Points |
|---|---|---|---|---|---|---|
| **Effort (25 pts)** | Hours actively engaged in research per week (25 pts)<br><br>1 credit translates to 4 hours | *100% research credit hours* | *75% research credit hours* | *50% research credit hours* | *≤25% research credit hours* | |
| **Organization and Lab Habits (25 pts)** | Completes safety trainings in a timely manner, performs work safely, and keeps clean workspace (15 pts) | *Complete safety training within 1 week of semester start, ask questions if you are unsure of how to proceed, keep workspaces clean, no major safety infractions* | *Complete safety training within 2 week of semester start, sometimes messy workspaces, no major safety infractions* | *Complete safety training >3 week of semester start, messy workspaces, no major safety infractions* | *Safety violation due to negligence or intention* | |
| | Maintains good documentation practices, and keeps files and samples in an organized, accessible condition (5 pts) | *Has good handwritten or typed documentation of work in lab notebook, good sample organization, and has left work in a readable and transferrable condition for incoming researcher* | *Has good lab notebook documentation of work, is slightly disorganized with sample/files* | *Only has few documentation of work, is not organized with sample/files* | *Did not keep any documentation of work, and has left work in difficult condition for incoming researcher* | |
| | Is helpful, respectful, open to feedback, and contributes to a positive environment in the lab (5 pts) | *Can receive feedback/ guidance from mentors and researchers in the group and immediately incorporate it, communicates concerns and questions, is respectful in lab area* | *Can receive feedback and guidance from mentors but is somewhat resistant to altering subsequent behavior, communicates some concerns and questions, is respectful in lab area* | *Struggles with receiving and implementing feedback, does not communicate concerns and questions, but is respectful in lab area* | *Is closed off to guidance from mentors and demonstrates disrespectful behavior* | |
| **Research Proficiency and Skill Development (25 pts)** | Demonstrates good lab/computational proficiency and increasing independence over semester (10 pts) | *At end of semester: independently accomplish assigned tasks, have clear understanding of fundamental topics, propose future directions* | *At end of semester: requires supervision to complete tasks, have poor understanding of fundamental topics, little understanding of future direction* | *At end of semester: cannot complete tasks, no understanding of fundamental topics, little understanding of future direction* | | |
| | Is curious, asks questions, and has demonstrated growth in research and lab skill development (7.5 pts) | *Has above average proficiency in one or more lab instruments/computational software* | *Has average proficiency in one or more lab instruments/computational software* | *Has less than average proficiency in one or more lab instruments/computational software* | *Has no proficiency in lab instruments/computational software* | |
| | Demonstrates good understanding research scope and overall topic (7.5 pts) | *Can clearly communicate all research objectives, and has obtained strong grasp of research background* | *Can state all research objectives, but lacks some research background* | *Misses some of research objectives, and has minimal research background* | *Merely performs tasks and does not know what research objectives are* | |
| **Deliverables (25 pts)** | Individual meetings with mentor: summary of results with suggested conclusions, and next steps to project planned (10 pts) | *Complete all reports with good quality* | *Complete most reports with varying quality* | *Complete few reports with poor quality* | *No reports* | |
| | Presentation: End of term presentation of work (7.5 pts) | *Give high quality presentation, provide draft prior to meeting to mentor, and incorporate feedback* | *Give medium quality presentation, fail to provide draft to mentor* | *Give low quality presentation* | *No presentation* | |
| | Summary: Written semester summary of work (7.5 pts) | *Provided summary in a timely manner* | | | *No summary* | |
| | | | | | *Total Points* | */100* |

***Figure 1.*** *Markita Landry Lab rubric for grading undergraduate research experiences (web).*

**Example rubric categories:** Brief overview of categories used in the Landry rubric.

1. Effort – Hours actively engaged in research per week. This category is used to set expectations for how much time students should be in lab to receive credit. This is a research independent category that any student should be able to accomplish.
2. Organization and habit – Safety, documentation, good lab citizen. This category sets expectations for operating in a research setting. This is a research independent category that any student should be able to accomplish.
3. Research proficiency and skill development – Increasing independence, curiosity, understanding of project. This category is research dependent and rewards scientific effort/aptitude. Establishes moving towards independence is rewarded.
4. Deliverables – Project meetings, presentation, written report. Trains students on communication deliverables.

**Example rubric scoring categories:**

1. Exemplary (90-100%)
2. Accomplished (80-90%)
3. Developing (70-79%)
4. Unsatisfactory (0-70%)*

The rubric weighs more heavily towards elements of successful undergraduate research (70-100% categories) and establishes the minimum students should be performing to succeed. It then

provides stepping stones for moving towards from developing to exemplary. The % assigned to each category is arbitrary, but follows grading % students might be most familiar with.

**Example rubric final grading scale.** Landry lab suggests the following grade scale breakdowns for rubric research (curved). Note – curve used in this rubric helps students map out a pathway to success. With this grading rubric, students scoring developing (70% in each category) will receive an A- in the research course (3.7 GPA). As stated earlier, the 70-79% category is the bare minimum students should strive to achieve as a researcher, with any unsatisfactory scoring warranting some form of correction.

| Points (↑) | Grade |
|---|---|
| 90 | A+ |
| 80 | A |
| 70 | A- |
| 65 | B+ |
| 60 | B |
| 55 | B- |
| 50 | C+ |
| 45 | C |
| 40 | C- |
| <40 | F |

***Figure 2. Grading scale for Landry lab URE.***

**Proper usage of grading rubric for undergraduate research requires tailoring rubric.** As general guidelines, undergraduate student mentors should tailor rubric for their own project. Changes that should be made are included below.

1. Rubric should be modified for specific research projects – For example, in research proficiency category, specify what skills you expect students to become proficient in (vs ones that independence is not expected).
2. Provide project description and research goals to student - For instance, a clear document detailing the project overview and expected outcomes should be handed over on the first day.
3. Provide student with safety guidance and ensure student can safely operate in their work setting – Rubric should be tailored to include a list of all safety training that should be performed. Additionally, information about how to complete the training should be provided.
4. Provide sufficient time, feedback, and guidance for student to meet required criteria – Student successfully transitioning from developing to exemplary categories might require additional feedback and mentorship from research mentor. Help them succeed by providing them to tools to be exemplary.
5. Give midterm grade on rubric to provide guidance on student's standing – This provides students an opportunity to improve if you can point out categories where they are not operating at satisfactory levels.
6. Give feedback on end-of-semester presentation prior to their delivery – Undergraduate research is rarely a one-and-done experience. Use the rubric as a means to provide constructive feedback so that student can continue to improve in their next quarter of research.

# Appendix A

**Overview.** Questions & Answers regarding our department undergraduate research engagement with Nicole Minkoff. Prior to starting to investigate questions regarding equitable research practices, I asked Nicole to tell us about the state of our undergraduate student engagement in research. Below you will find the questions asked (bold) with Nicole Minkoff's answers (unedited).

**Statistics and engagement:**

**Q: Number of undergraduates involved in our involved in research?**
A: Before the pandemic, we were up to about 70% of seniors graduating having done some research. This year, it's looking closer to 50% (36 students in the senior class, 25 so far among the younger classes).

**Q. Number of undergraduate transfer students involved in research?**
A: 11 transfer students are involved in research as seniors currently, which is 40% of the seniors at large

**Q. Year undergraduates start research opportunities.**
A. Varies widely from 1st year to senior year, with most starting 2nd and 3rd years

**Q. Methodology used by ug students to find research opportunities, and attrition in the search process.**
A. We send out research when we hear about it, but students are also encouraged to write to faculty they're interested in working with. There's a lot of non-responsiveness.

**Q. Number of years/quarters students stay doing research.**
A. Varies widely. A small handful realize quickly it's not for them and do 1-2 quarters, but most do at least 3 quarters. There's a decent handful (I'd say probably 10-15) who do research for 2.5 years or more

Q. Average number of labs students do research in (i.e. leave a lab to do new research in another lab).
A. Most students only do research in 1 lab, maybe 5/70 of any graduating class have done research in more than one lab.

**Q. Outcomes of students (industry job? grad school?) of students doing research.**
A. Nearly everyone who goes to grad school does research, but we have a lot of people who do research and go to industry. 85% of our students go to industry and only 15% to grad school or professional school, but with 50-70% doing research, a lot of people are doing research and going to industry.

**Q. How many faculty advertise research opportunities per quarter/year (on average)**
A. It's only in the last year that we've been combining them at all for us to know (instead of completely grassroots and thus opaque to the dept), and it's grown from 1-2 to probably 4-5/quarter.

**Q. What is the general level of interest for students looking to do research (stats along the line of e.g. 50% want to do research, only 20% find opportunities?)**
A. Anecdotally, I think most students who want to find research eventually do, although I know there are some who don't.

**Q. Demographic breakdowns, class breakdowns would be useful as well.**
A. women are fairly evenly involved in research, URM students are underrepresented in research in our junior and senior classes but are participating at much higher rates (double) of non-URM students in our sophomore class. International students are participating at almost twice the rate as non-international students. Students planning to go to grad school are also participating in undergraduate research at a much higher rate.

**Q. How these numbers have fluctuated over the past years could be helpful as well.**
A. The classes of 2015-2018 hovered around 45-50% participating in research. In 2019, it rose to 55% and in 2020 it rose to 77%. We don't have data for the class of 2021, but I'm sure it was pretty low due to the pandemic, and the class of 2022 had 67% reporting research at the time of graduation. It's possible that the class of 2023 (currently sitting at 50%) will go up by the end of the year when we ask them about it, but I would expect not by too much, since most students have started research by now if they're going to.

**Communicated to students:**
**Q. What general information is communicated to students about finding opportunities?**
A. Our areas of impact websites have this information:
Over 70% of BS ChemE students participate in undergraduate research while earning their degrees. Students can do undergraduate research in any engineering lab and count up to 9 credits toward engineering electives for degree requirements. Most research opportunities are not posted on the website. The best way to get involved is to read about the faculty on our research pages and email the professor you're most interested in researching with to see if they have space in their lab. ChemE faculty are on the cutting edge of research in the following areas:

**Q. What resources do students currently have provided by the department?**
A. Students meet with advisers to get encouragement, there's an undergraduate research peer program (at UW) that can help students navigate the process, and AICHE often does a "getting involved in research" presentation at some point during the year. We also advertise options on a quarterly basis to ChemE students, ENGRUD students, and a handful of other programs (I.e. LSAMP, STARS, Engineering Deans Scholars, transfer students when opportunities include REUs or other options for off campus students).

CHEMICAL ENGINEERING
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# Appendix B – Example Graduate Admission Rubrics

## B.1 - UW ChemE

| | |
|---|---|
| **Academics** | |
| 4 | Perfect academic performance, perhaps with double majors |
| 3 | Strong academic performance OR moderate but strong upward trajectory |
| 2 | Moderate performance - courses were clearly not a passion |
| 1 | Weak - barely snuck by |
| | |
| **Research and Service: Achievements and Potential** | |
| 4 | First-author on a research manuscript, national conference presentations, awards, outstanding service in leadership role in ChemE-related groups |
| 3 | Co-author on a manuscript, local research presentations, some awards, some leadership in ChemE-related groups |
| 2 | Applicant has demonstrated commitment to a research lab as an undergrad for >1 year, involved in ChemE-related groups |
| 1 | Limited to no research experience, <1 year experience in a group (or in combination within several groups) |
| | |
| **Self-Direction and Motivation (*Maturity of thought & self-presentation)** | |
| 4 | Exceptionally motivated (perhaps by reason to be in NW), clearly knows how grad school at the UW fits into their goals, for example: non-traditional background, returning from industry |
| 3 | Strong understand of why graduate school, what labs/opportunities exist at UW, and where want to go post-grad |
| 2 | Some clarity with respect to future research directions and life goals, and has identified possible research area or potential advisors |
| 1 | Limited ability to state goals, not clear why want to attend grad school |
| | |
| **Letters of Recommendation** | |
| 4 | "Best student ever", "Top 1%" or similar language from reputably writers, consistent views shared by all letter writers |
| 3 | "Top 10%" or similar language from at least two letter writers |
| 2 | Favorable letters, but not overly glowing; possible inconcistancies between writers; potentially only one very strong letter |
| 1 | Weak letters; major inconstancies between evaluator recommender comments |
| | |
| **Wiggle Factor** | |
| Possible values = 0, 1, 2. Many (if not most) applicants will receive a 0 here. Some examples of reasons to award points include: | |
| | Exceptionally strong overlap/fit with many ChemE faculty research areas |
| | Champion of diversity |
| | Personally faced and overcame unique challenges to get to where they are |
| | Personal reason to be in the PNW (family, etc) |
| Could be used to offset potential bias in rec letters, where language use is disproportionately unfavorable to women and underrepresented minorities | |

## B.2 - UW MolE

| | "1" (Below expectations) | "2" (Meets expectations) | "3" (Above expectations) | "4" (Exceeds expectations) | Notes | Score |
|---|---|---|---|---|---|---|
| **Academic preparation to date**<br>• Relevant coursework<br>• GPA | <3.3 | 3.3-3.5 | 3.5-3.7 | 3.7-4.0 | | |
| **Potential to contribute to MolES research**<br>• Research experience<br>• Enthusiasm for science and research<br>• Commitment to the interdisciplinary nature of MolES (knowledge of program and potential advisors)<br>• Experience presenting at a conference or symposium<br>• Non-traditional evidence of potential (science policy activism, hobbies, or personal interests) | Little or no evidence of potential to contribute to research at UW MolES | Evidence of research experience through senior thesis, capstone project, internship, or REU. | Strong evidence and clear articulation of research experience through senior thesis, capstone project, internship, or REU with explicit examples of outcomes (publication, conferences, etc.) | Multiple concrete examples where the student demonstrated potential to contribute to MolES research | | |
| **Persistence and commitment to personal success**<br>• Upward academic trajectory (if GPA <3.5)<br>• Clear goals for PhD<br>• Goals beyond PhD<br>• Proven dedication and progress toward career/life goals<br>• Overcoming personal obstacles<br>• Non-research job experience<br>• Long-term commitment to activities | Little or no evidence of personal persistence and commitment | Evidence of persistence and commitment | Strong demonstration and evidence of persistence and commitment in academics, research, and/or personal life. | Multiple concrete examples where the student has excelled due to persistence and commitment in academics, research, and/or personal life | | |
| **Commitment to improve society and benefit others**<br>• Outreach/volunteer work<br>• Activities outside of academics<br>• Plans to contribute to outreach, DEI, service<br>• Mentorship<br>• Teaching and tutoring experience | Little or no evidence of commitment to improve and benefit society | Some evidence of activities to improve society and benefit others | Strong evidence of committed (sustained) efforts to improve society beyond academics | Multiple concrete examples where the student has shown sustained commitment to improve society and benefit others. | | |
| **Demonstrated ability to collaborate**<br>• Participation in athletics, clubs, or other team building activities<br>• Examples of teamwork and collaboration | Little or no evidence of collaboration or teamwork | Some evidence of teamwork and/or collaboration | Strong evidence of commitment to teamwork and/or collaboration | Multiple concrete examples of teamwork and collaboration | | |

## B.3 – UCB/UCSF BioE

| Category | High | Medium | Low | Notes |
|---|---|---|---|---|
| Academic preparation | Has three or four of the following attributes:<br>- Engineering/STEM classes<br>- High GPA in STEM (last two years)<br>- Programming / other technical experience<br>- Selective institution / rigorous program | Has one or two of the attributes identified in the “High” column | Has none of the attributes identified in the “High” column | GRE can complement grades, if available |
| Scholarly potential | Has research experience with ample evidence of leading role e.g. papers, presentations, key phrases in rec letters (e.g. “leader”, “original contribution”, “grad level”), patents, teaching, prizes, scholarships/grants, mentorship of junior students | Limited research experience; no/weak evidence for leadership roles or sustained commitment | Little or no research experience | Content of letters and papers are most predictive of PhD success |
| Non-cognitive competencies | Excellent self-management. Overwhelming evidence of leadership, initiative, extracurricular accomplishment, adversity overcome, commitment, and/or mentorship | Strong evidence of self-management, empathy, and/or social competencies | Moderate or no evidence | See overleaf for further discussion |
| Alignment with program | Interests closely match graduate group’s research areas; possible mentor can be identified (explicitly or implicitly) | Interests align, but generically | Unclear what they’d work on | |
| Diversity, equity, and inclusion | Outstanding plan to advance diversity OR evidence of unique/different perspectives. Would greatly advance program’s DEI | Moderately advances program DEI | Neutral from a DEI perspective | Must be based on applicant’s own words |

## B.4 – UW Chemistry

| | "1" (Below expectations) | "2" (Meets expectations) | "3" (Above expectations) | "4" (Exceeds expectations) |
|---|---|---|---|---|
| **Academic preparation to date**<br>Relevant coursework<br>GPA | <3.3 | 3.3-3.5 | 3.5-3.7 | 3.7-4.0 |
| **Potential to contribute to chemistry research**<br>Research experience<br>Enthusiasm for science and research<br>Commitment to our research program (knowledge of program and potential advisors)<br>Experience presenting at a conference or symposium<br>Non-traditional evidence of potential (science policy activism, hobbies, or personal interests) | Little or no evidence of potential to contribute to research at UW | Evidence of research experience through senior thesis, capstone project, independent learning contract, internship, or REU. | Strong evidence and clear articulation of research experience through senior thesis, capstone project, internship, or REU with explicit examples of outcomes (publication, conferences, etc.) | Multiple concrete examples where the student demonstrated potential to contribute to research |
| **Persistence and commitment to personal success**<br>Upward academic trajectory (if GPA <3.5)<br>Clear goals for PhD<br>Goals beyond PhD<br>Proven dedication and progress toward career/life goals<br>Overcoming personal obstacles<br>Non-research job experience<br>Long-term commitment to activities | Little or no evidence of personal persistence and commitment | Evidence of persistence and commitment | Strong demonstration and evidence of persistence and commitment in academics, research, and/or personal life. | Multiple concrete examples where the student has excelled due to persistence and commitment in academics, research, and/or personal life |
| **Commitment to improve society and benefit others**<br>Outreach/volunteer work<br>Activities outside of academics<br>Specific plans to contribute to outreach, DEI, service<br>Mentorship<br>Teaching and tutoring experience | Little or no evidence of commitment to improve and benefit society | Some evidence of activities to improve society and benefit others | Strong evidence of committed (sustained) efforts to improve society beyond academics | Multiple concrete examples where the student has shown sustained commitment to improve society and benefit others. |
| **Demonstrated ability to collaborate**<br>Participation in athletics, music ensembles, clubs, or other team building activities<br>Examples of teamwork and collaboration | Little or no evidence of collaboration or teamwork | Some evidence of teamwork and/or collaboration | Strong evidence of commitment to teamwork and/or collaboration | Multiple concrete examples of teamwork and collaboration |

# Appendix C

**Undergraduate Research Mentor Workshops** - The Office of Undergraduate Research launched a new workshop in 2023 for anyone involved in the undergraduate mentorship pipeline. Faculty, senior fellows, postdocs, graduate students are invited to attend.

**Dates (In Person) - Mary Gates Hall Suite 171.**

- October 26th from 10:00-11:00 a.m
- October 27th from 1:00-2:00 p.m.

**Dates (Virtual)**

- November 8th 12:00-1:00 p.m

**Those who attend this session will:**

1. Learn effective and equitable strategies for recruiting undergraduate researchers.
2. Learn about undergraduate research funding opportunities, including funded programs, research scholarships, and conference travel support for undergraduates.
3. Explore other ways to compensate undergraduates for their work (e.g. Federal Work Study, course credit, etc.).
4. Learn about UW's Undergraduate Research Symposium and how to prepare students to present.
5. Learn how to get students in your courses excited about participating in research.
6. Discover ways to connect with undergraduates interested in research.
7. Gain access to additional resources for effective and inclusive mentorship.
8. Build relationships with Office of Undergraduate Research staff who can support you in grant development, program and curricular design, and other topics.

**Information regarding the workshop can be found here:**
https://www.washington.edu/undergradresearch/mentors/undergraduate-research-mentor-workshops/

# Appendix D

**Literature cited and additional resources:**

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