Teaching and Learning the Chemistry that Isn't Taught in the Classroom

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Informing Values

- **Communication is key** – two-way communication between student(s) and educators establishes trust and expectations
- **Students will be more engaged with their work if they have ownership of it** – personal ownership of the work can trigger the affective domain of learning in students, and help to build self-motivating habits in a research lab
- **It is equally important to know what work you *don't* enjoy as knowing what work you do enjoy** – my goal as an educator and research mentor is for students to come away with an informed experience that can guide their future aspirations and without negative experiences

Student Learning Outcomes

- After an introductory meeting, students will write their own learning outcomes for their tenure in the research lab*
- At the beginning of the semester, students will be provided with materials that supplement their knowledge of the research. Throughout the semester, students will then apply this knowledge towards computational research of covalent organic frameworks (COFs)
- At the conclusion of their time in the lab, students will be able to evaluate their future career motivations as influenced by their experience in this lab

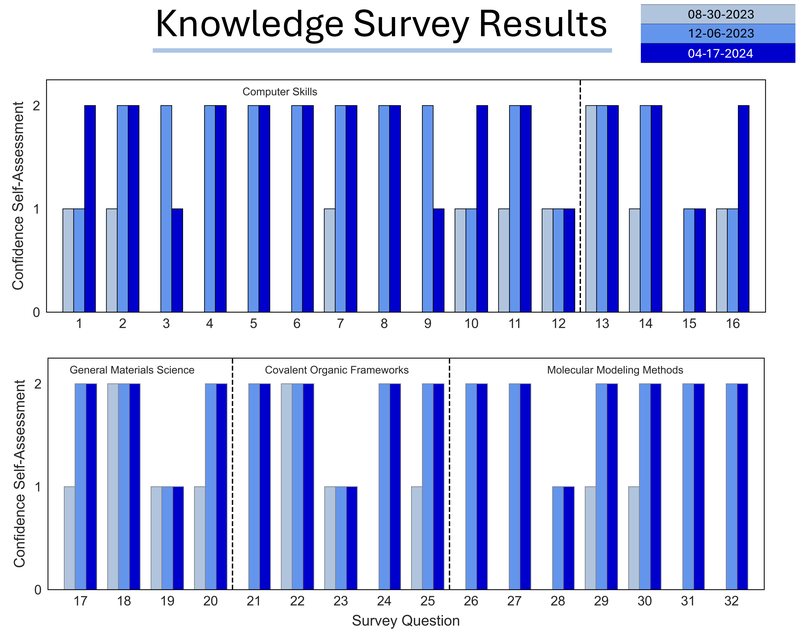
Assessments

- **Knowledge surveys** – administered pre, mid, and post-semester
- **Student-written rubric for personal outcomes *** – students will work closely with me to develop a rubric that outlines the level of accomplishments necessary to achieve each of their own written outcomes
- **Apply their knowledge and skills to research questions** – the students' ability to carry out simulations of materials and interpret error messages and data is used as a formative assessment
- **Regular discussions and meetings** – these meetings also work as a formative assessment, and provide the opportunity to determine weekly goals that will advance the research question

Aligned Pedagogies

- **Differentiated Instruction** – recruit the students' interest[1] and establish a sense of belonging[2]
- **Self-Assessment** – developing executive function and setting explicit[1] expectations[2]
- **Flipped Classroom** – provides multiple means of representation[1], designed with accessibility[2], and to clarify vocabulary and syntax[1]
- **Discussions** - reflect on my own abilities and beliefs[2]
- **Problem-Based Learning and Models**

Knowledge Survey Results



- The overall knowledge survey results indicate that Taylor's confidence improved from **33%** to **89%**
- Taylor improved in all areas…
  - She began the year with the highest confidence in *General Materials Science* and the lowest confidence in *Molecular Modeling Methods*
  - She ended the year with the highest confidence in *Molecular Modeling Methods* and the lowest confidence in *General Materials Science*
  - Her confidence at the end of the year was equal in *Covalent Organic Frameworks and Computer Skills*
  - At the end of the year, she showed the most improvement in *Computer Skills* and *Molecular Modeling Methods*

Future Considerations

- Certain questions can be removed all together from the knowledge survey because they were never addressed throughout the year and were deemed irrelevant upon reflection
- To better address other questions in the survey, a summative assessment can be implemented in the form of a final "report" on which includes interpretation of formal data analysis, such as X-ray diffraction, surface area analysis, and stability
- A broader range of topics can be covered to introduce the student to more concepts and find out what they are the most interested in rather than having a narrow area of focus from the beginning.

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To all my LAMP classmates, for the stimulating and silly conversations

Informing Values – Student Perception

- Communication was a huge factor in my eagerness to contribute. It always felt like my opinion was valued and I could always share my thoughts.
- I was excited to work on both projects throughout the year because I had either suggested or decided between what was offered.
- I came into this research with the mindset that I did not enjoy lab work at all and would do my best to complete the hours. I was happily surprised when I realized that I enjoyed the type of work we were doing, and this was my first experience with computational research.

Student Learning Outcomes

- First semester, my primary goal was to get comfortable with the software, improve my coding skills, and make a helpful contribution to the group. I think my expectations were a little ambitious since I didn't have a grasp of what we were really going to be doing. By the end, I had a much better understanding of what we were doing, and I was proud of what I had accomplished; so much so that I wanted to do another semester. The second semester, I set more realistic goals for myself.
- I feel much more confident in my ability to comprehend the information from a research paper on COFs and on the software. With software, although I might not know exactly what to do with an error message, but I know where to look and what to try to solve it.
- After this experience, I realized I'd like to pursue further self-guided education. I have had—it pains me to say—fun learning to code. In the future, I might enjoy computational work or continuing to program as a hobby.
- It may have been helpful to come up with my own learning outcome with some guidance in order to have a clear goal for the upcoming semester.

Assessments – Student Perception

- The knowledge survey was hard and a little embarrassing to take the first time. After a few weeks of learning, I felt a huge increase in my abilities and my confidence continued to grow exponentially. Although there are still many things I don't know, I no longer feel embarrassed, but rather, excited to keep learning.

Pedagogies – Student Perception

- I always felt that my contribution to the group was valuable, no matter how small. I always had something to show for the calculations that I ran or the time I spent editing code, and this kept my motivation high.
- The learning materials were very helpful when I was beginning. I also liked that even when we were working together, I could go back and check the reference material without being given the answer.
- When we worked together, it was good to hear feedback about the skills you saw improvement in.

References

1. The Universal Design for Learning Guidelines (UDL) Version 2.2. http://udlguidelines.cast.org, 2018. CAST.
2. L. Appert, C. S. Bean, A. Irvin, A. M. Jungels, S. Klaf, and M. Phillipson. Guide for inclusive teaching at columbia. Columbia Center for Teaching and Learning, 2017. 12