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A Chemistry Instructor's Teaching Philosophy Statement

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My Teaching Journey

When the topic of chemistry is mentioned in conversation with peers or loved ones, I usually find that they chuckle about their struggles with the subject. They shudder at the thought of memorizing dozens of vocabulary words, elements, and numerical constants, rounding every measurement to the correct number of significant figures, and calculating quantities that can go as high as one hundred thousand trillion. Unlike their experience, when I was in high school, I found myself guiding my peers through the foundational concepts tied to each chemistry experiment and serving as the president of my Science Olympiad team. This passion for science and peer mentorship continued into my undergraduate years, when I volunteered to proctor a Science Olympiad event and supported students in a general chemistry laboratory course as a learning assistant.

After earning my bachelor's degree in chemistry, I took a gap year to gain industry experience before entering a master's program. As I was working on my master's degree in chemistry, I taught a few general chemistry laboratory courses as a graduate teaching associate. My interest in education evolved as I supported the academic success of students from diverse backgrounds each semester. By doing so, I worked to cultivate a learning environment in which a diverse group of scientists could approach challenges from a wider variety of perspectives. I have since combined my passions for chemistry and education to pursue a career path as a full-time, tenure-track chemistry professor at a community college. To prepare myself for this path, I currently teach chemistry part-time at a California State University as well as local community colleges.

Developing a teaching philosophy statement using the Methods, Theories, & Values/Beliefs framework, or MTV, has been an important aspect of my preparation for the faculty hiring and evaluation processes. Engaging in this reflective process has enabled me to more intentionally choose pedagogical methods and to better understand and articulate the learning theory that supports my values and beliefs. This way, my choices in the classroom are direct manifestations of my core values.

Values and Beliefs

As a chemistry instructor, my core values are *accessibility*, *collaborative agency,* and *intellectual empowerment*. Accessibility serves as the essential entry point, removing mathematical, physical, and cognitive barriers for a diverse student population. This entry point serves as a foundation for a classroom environment with collaborative agency, in which students build deeper conceptual understanding through developing communication skills necessary for professional discourse. Such a classroom environment ultimately yields intellectual empowerment, allowing students to take ownership of their scientific knowledge and engage critically with the world around them.

To cultivate these values, my teaching practices are rooted in *critical thinking skills* and *active learning,* the latter involving students engaging in higher-level cognitive tasks such as analyzing, creating, and evaluating (Bonwell & Eison, 1991). I believe that encouraging students to approach the material with a curious lens allows them to think critically about chemistry concepts and inspires them to approach their peers' ideas with an open mind. By fostering critical thinking and active learning, I can provide students with the intellectual empowerment they need for professional endeavors, while ensuring the subject remains accessible and grounded in collaborative agency.

Theory: Social Constructivism

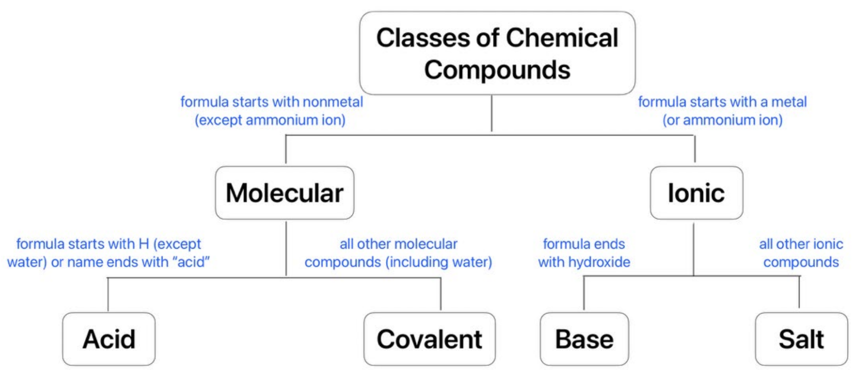
My pedagogical values of *accessibility*, *collaborative agency,* and *intellectual empowerment* are supported by the *social constructivism* theory, which proposes that knowledge is co-constructed with peers and the instructor in a social learning environment (Vygotsky, 1978). In the realm of chemistry, students are provided several opportunities to co-construct knowledge (learn from and with one another) in laboratories and lecture halls. In a laboratory course, students are often more engaged when they can rely on advice from their peers and learn from shared experiences facilitated by the instructor, such as performing group laboratory experiments (Barr et al., 2022), as opposed to performing individual activities. As a result of student collaboration to build upon different interpretations of experimental data, critical thinking skills are developed to more deeply reflect on experimental results and how they connect to chemistry concepts introduced during the lecture courses. Even in the lecture format, I aim to provide opportunities for co-construction of knowledge based on Vygotsky's theory of social constructivism to maximize student engagement while ensuring that all the required material is covered by the end of the semester. I find that, in both the lab and lecture formats, I also learn from my students as they share their perspectives in class or with each other during group activities. When they share their academic misconceptions, I gain insight into how I can modify my lessons to better guide my students through the course material. Facilitating activities that promote collaboration and co-construction of knowledge among peers and the instructor is essential for creating the classroom environment that I desire to manifest. The opportunities for student collaboration, co-construction of knowledge, and learning from my students are executed through specific methods detailed in the following section.

Pedagogical Methods

The social constructivism theory and my classroom values are pillars that guide my chosen teaching methods. My chemistry lessons are often based on *inquiry-based learning* – a framework (Bybee et al., 2006) or method where students use their prior knowledge to devise ideas and explore questions related to place- or problem-based situations (Pedaste et al., 2015). For example, two of my students once asked me why their titration data seemed odd compared to that of their classmates. Rather than listing all the possible sources of error for them to ponder on their own, I posed questions so that they could retrace their steps and discover the explanation for their unusual data together. *How did they dilute their solution of strong base? Which strong base solution did they use to neutralize the acid, the original or the diluted? Why did the original strong base solution produce unusual results?* This series of questions led them to understand that diluting solutions is a useful technique for producing results within a measurable range. From a co-construction stance, this approach also led me to understand the sources of confusion that students sometimes encounter when preparing titration solutions, such as knowing which concentration of strong base they should use to neutralize their acid solutions. This laboratory scenario exemplifies how I engage students' curiosity and collaboration by posing questions and encouraging students to collectively reflect on potential sources of error. As students explore and resolve errors, they develop critical thinking skills that can benefit future academic and professional pursuits.

To aid students in developing the much-needed critical thinking skills, I also utilize the *cognitive apprenticeship* method, which involves making the thinking processes to solve problems visible so students can practice and co-construct knowledge with the instructor and their peers (Collins & Kapur, 2014). I provide the concept map in Figure 1 to my introductory chemistry students approximately a month into the semester to introduce the process of classifying chemical compounds into four categories: acids, bases, salts, and covalent compounds. Prior to giving students five to ten minutes to classify chemical compounds on their own, I think aloud about an example of each type of compound introduced in lecture. For instance, to classify table salt or NaCl, I first ask my students if its chemical formula starts with a metal or nonmetal element. *Since its chemical formula starts with the metal sodium or* Na^+*, I infer that the compound is ionic and thus is likely to be classified as either a salt or a base.* To decide between these two categories, I then ask if the chemical formula for table salt ends with the hydroxide ion or OH^-. *Because NaCl does not end with hydroxide, or* OH^-*, I conclude that this compound should be classified as a salt instead of a base.*

Figure 1. *Concept Map of Classification of Chemical Compounds*

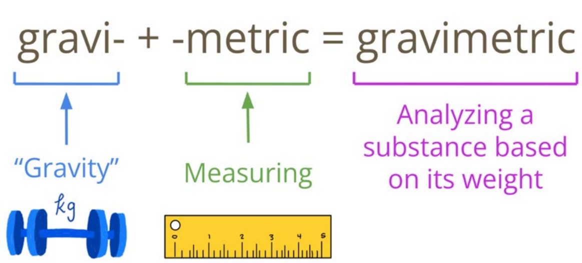


The method of cognitive apprenticeship has been useful in supporting students' engagement with challenging and confusing concepts. One such challenge includes the question of why ammonia or NH_3 (not to be confused with the ammonium ion or NH_4^+) would be classified as a base if its chemical formula does not contain a metal or end with the hydroxide ion. Students eventually discover that the answer to this question lies in the principles of dissolving acids and bases in water. Think alouds (Frey et al., 2020) allow me to clarify potential points of confusion for students by verbalizing my own thinking through example scenarios. Such guided scaffolding allows students to discover the solutions to similar challenging and confusing problems on their own.

Another method that I use to help my students grasp difficult material is *multisensory learning*, which allows students to process information through multiple physiological senses (Shams & Seitz, 2008). While students traditionally learn by watching and listening to an instructor model and explain each lesson, I find that it is more effective for students to employ as many senses as possible to process knowledge in multiple ways. This is particularly helpful in chemistry, as the traditional lecture method we often use can exacerbate the all-too-common feelings of fear or insecurity associated with learning chemistry. A challenging topic for many students is the distinction between units in the English and metric systems. In my laboratory classroom, students engage with tactile props that represent units of length, mass, and volume from both systems. For example, to compare mass, students hold a small piece of cardboard representing one gram and a wooden block representing one ounce. By feeling the difference in weight, students can better understand that an ounce is heavier than a gram. This tactile method transforms abstract concepts into concrete, memorable experiences.

I would also dedicate time before they start performing each experiment to break down any difficult chemistry jargon. For instance, when I describe gravimetric analysis, I would break down the word *gravimetric* into two parts, *gravi-* (meaning gravity or weight) and *-metric* (meaning measuring), by displaying a visual aid that demonstrates this breakdown and how it contributes to the overall meaning of the word as shown in Figure 2.

Figure 2. *Visual Breakdown of the Word "Gravimetric"*



A key step in this process is to enunciate *GRAV* and *METric* to verbally emphasize each part's meaning. To enhance the breakdown of this vocabulary word, I would also prompt students to imitate my kinesthetic movement, which involves pretending to put down heavy weights with both hands and then pulling out measuring tape. These aspects of my lesson help students to piece together that *gravimetric* analysis means analyzing a substance based on its measured weight. If students can use words they already know to both understand and retain the meaning of new jargon, the concepts become more approachable. When I integrate multisensory learning into my teaching, my lectures serve as avenues for introducing key principles on the atomic and molecular levels using visual, auditory, and kinesthetic strategies while my labs provide tactile methods for students to observe phenomena on the macroscale level (Seery, 2020). Since the abundance of intimidating vocabulary often acts as a barrier for students' chemistry learning experience, employing multisensory strategies dismantles this obstacle, providing an accessible entry point for diverse learners to master difficult concepts.

Concluding Statement

I believe that students require classroom environments conducive to active learning and the development of critical thinking skills. My values of *accessibility*, *collaborative agency*, and *intellectual empowerment,* are informed by the theory of social constructivism, which suggests that students learn most effectively when they co-construct knowledge with peers and the

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instructor in a social learning environment. Ultimately, my values, beliefs, and the social constructivism theory form the foundation for my pedagogical approaches, which include inquiry-based learning, cognitive apprenticeship, and multisensory learning. While chemistry is a notoriously difficult subject, I strive to make it more approachable so that students may appreciate the molecular world around them and gain knowledge and skills that are transferable to any career path. My goal is to provide a supportive learning environment in which students can take intellectual risks in the classroom without fear of judgment, thus fostering the resilience and curiosity necessary for lifelong scientific literacy.

Final Reflection

Utilizing the MTV teaching philosophy framework has illuminated the substance and rationale behind my pedagogical approaches. I started out as a graduate teaching associate without any experience; thus, I only based my lessons on the expectations outlined by the course coordinator. At the beginning of each lab period, I would give students weekly lab quizzes, introduce new vocabulary and calculation methods by writing definitions and formulas on the chalkboard, demonstrate new techniques and equipment, and remind them of assignments that are due the next week. After they finished performing each experiment, I would sign my initials on their lab reports and hand students back any graded work from the previous week. *As long as I just follow these directions, I will be a good chemistry instructor,* or so I thought. One semester, when one of my students struggled with a hydrated metal sulfate experiment, she was concerned about not being able to complete the lab report using data for only one trial. I promptly responded to her email, assuring her that she will still get credit for using the data she obtained and that many students also struggle with heating the hydrated metal sulfate using the Bunsen burner for the first time. She responded, “Thank you so much for your help and words, you always make the classroom a nice environment!” It was this moment when I realized there is more to teaching chemistry than the subject itself.

This realization drove me to participate in a professional development program dedicated to preparing graduate students without prior pedagogical training to teach in higher education. First, I started by exploring the foundations of teaching and learning, such as functions of the brain, learning domains, the components of a teaching philosophy, and student-centered pedagogical approaches that are conducive to a diverse learning environment. Then, I collaborated with my peers to apply various teaching methods, such as multisensory approaches, to design and present a teaching demonstration. Not only was I inspired by the variety of contributions from my peers, but I also received positive, constructive feedback from the leadership team and felt that the project helped me to actively strengthen my understanding of each pedagogical method. For instance, by taking time to break down difficult vocabulary using multiple senses, I will be better able to connect with a diverse student population regardless of differences in academic, socio-economic, cultural, disability, and ethnic backgrounds.

The opportunity to participate wholeheartedly in the professional development program led me to refine my teaching philosophy statement in a collaborative author writing community. Exchanging positive, constructive feedback with colleagues from diverse disciplines has taught me that deliberate word choice is essential for articulating my pedagogical identity. Thanks to the thoughtful advice and support from my colleagues and mentors, I have moved from a surface-level description of how I teach to a more nuanced articulation of how my values, beliefs, and supporting learning theory are translated into my daily instructional practices.

The insight that I gained from my professional development experiences, and the articulation of my teaching philosophy has been guiding me to teach with more intention. I now circulate the laboratory to engage in discussions with my students about their progress for each experiment, respond to their questions by guiding them to retrace their steps, and take extra time at the beginning of the lab period to break down difficult jargon. As I cultivate my teaching skills, I am continuing to work towards my goal of becoming a full-time, tenure-track chemistry professor at a community college.

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