FACULTY DEVELOPMENT PLAN

Chemistry & Biochemistry
August 2024

A. Self-assessment

I. Teaching

Student reviews highlighted a few strengths. Most positive comments focused on my ability to connect with the students and demonstrate that I cared about them and their learning. I easily remember names of those who participate more in class or attend office hours, but I also practiced learning their names with flash cards. A second common positive comment was that I could explain difficult concepts in a more understandable way without appearing condescending. The two Aims of a BYU Education that were scored lower were “Character building” and “Leading to lifelong learning and service”. Many students appeared to recognize the course difficulty as character building, but I can improve in these areas by intentionally incorporating these ideas into lessons and class activities. Chemistry – as well as science in general – has many ethical issues that I can discuss with the class to help them build strength of character. For lifelong learning and service, I can draw more explicit connections between the concepts they are learning to real world applications that improve health and quality of life.

II. Scholarship

My research experiences as a graduate student and postdoctoral fellow have strengthened my confidence as an independent scientist. I know how to approach a scientific question, develop experiments, and comprehensively examine results. Because I have mostly dealt with challenging problems in fundamental chemistry and instrument development, I have a strong determination to solve these types of problems. Because I am self-motivated and independent, I tend to encourage and expect those same qualities from students in my lab. I believe that this approach will ultimately benefit them, but I also need to learn to adjust my mentoring style for all types of students – particularly those who need more initial guidance.

III. Citizenship

I currently serve on our department’s graduate recruitment committee. One of my strengths is that I genuinely enjoy working with a group of peers on a shared goal. I also know how to accomplish tasks in a timely manner without allowing them to infringe on my teaching and research responsibilities. My main area of improvement is simply gaining more experience in addressing broader, department level questions that extend beyond my classroom and research group. I also need to start finding opportunities to serve outside the department and university.

B. Goals

I. Teaching

1. <u>Emphasize real world applications and importance of chemistry concepts</u>

Chemistry is a challenging subject for many people; however, I believe that a general misunderstanding of the application of chemistry is the true barrier in student comprehension. Students tackle other difficult subjects and master challenging skills, because they attach importance to these subjects and skills. I plan to incorporate more applications and connections

in lessons and assignments that will motivate students to care about chemistry, rather than teach concepts as technical ideas that only apply to a research laboratory.

2. Unify course structure across topics, assignments, and assessments

I plan to iteratively improve the structure of courses that I teach by (1) identifying the key concepts, (2) designing assignments that help students learn and practice each concept, and (3) creating assessments that fairly test student mastery of concepts. Assignments will include pre-class assignments, in-class activities, and post-class assignments. Short pre-class work will encourage reading material in preparation for each class. In-class activities will be challenging but students will work in groups and be graded by participation. Post-class assignments will include standard to more difficult problems designed to help students practice the types of problems that will appear on exams. Many students struggle with exams because they fail to see exam problems as natural extensions of problems they solved on assignments. I plan to adjust exam structure to include problems that directly correlate to previous assignment problems as well as problems that combine multiple concepts or challenge students to stretch their understanding of concepts in new ways. The balance of problem difficulty will be designed so that a student who can replicate mastery of previous assignments achieves a “B”, whereas a student who demonstrates additional mastery of concepts achieves an “A”.

3. Update mass spectrometry topics in courses and develop an advanced graduate-level course

Mass spectrometry has been a rapidly growing and maturing field for many years; however, its presentation in organic and analytical chemistry courses has remained largely unchanged. One strong evidence of this outdated presentation is the fact that organic chemistry students are taught to interpret mass spectrometry data generated by obsolete instrumentation in the classroom, but then collect data from more modern instrument in the laboratory. Using my experience and expertise in fundamental and applied mass spectrometry, I plan to work with professors assigned to curriculum development to update lecture materials. Because mass spectrometry is a growing field that many graduates will likely encounter in their careers, I also plan to develop our current mass spectrometry graduate-level course into two courses. The lower-level course will be introductory in nature, whereas the upper-level course will provide more detail for students who are interested in pursuing mass spectrometry-based research.

II. Scholarship

1. Establish a self-sustaining research group

I plan to apply for long-term and stable external grants so that I can support an experienced postdoctoral researcher, five graduate students, and five to ten undergraduate students. The postdoc will help with lab management and training, which will allow me to focus on mentoring students and helping them create new research directions. Currently, I believe five graduate students will allow us to produce high-impact research without removing me completely from meaningful interactions with each of them. The five to ten undergraduates will be divided among graduate students so that each can be actively involved in research projects. This structure will also give mentoring experience to the graduate students.

2. Define my research area

From my observations of successful analytical chemists, I have noticed that each has a well-defined niche that they are able to exploit because of unique instrumentation and/or methodologies. The two expertise I have from my graduate and postdoctoral research are utilizing mass spectrometry to (1) perform gas-phase chemistry and (2) prepare samples for surface-

based analysis. My current plan is to develop these two techniques on a research-grade mass spectrometer and incorporate them into unique methods that can address difficult bioanalytical and biophysical problems.

3. Help every student submit a research article and present at a conference every year

I plan to attend the yearly conference of the American Society for Mass Spectrometry. The size and breadth of this conference allows students to see many unique developments and applications of mass spectrometry and provides ample opportunity for undergraduate and graduate student participation. I plan to support all my students in attending and presenting at this conference. These presentations can then be refined and submitted as research articles for publication.

III. Citizenship

1. Develop and maintain relationships with specific undergraduate universities

Last fall I visited Utah Tech in Saint George, UT to present my past research and advertise our undergraduate summer programs and graduate program. I met with several professors and students and learned about the environment at Utah Tech. I plan to volunteer to visit again this coming graduate recruitment cycle to hopefully facilitate creating a stronger pipeline of incoming students. I also plan to volunteer to visit SUU in Cedar City at the same time because the two universities are close in proximity.

2. Volunteer to participate in ASMS

I have attended the Conference for the American Society for Mass Spectrometry regularly since starting graduate school. I plan to help chair a workshop for the next two years and subsequently volunteer for other conference roles. I also plan to volunteer as a reviewer for the society's journal.

C. Relationship of goals to department and university needs

The Department of Chemistry and Biochemistry aims to provide a strong educational experience "by offering rigorous classroom instruction coupled with experiential learning in our research labs" and "offering opportunities at the cutting edge of our discipline" (BYU Chemistry & Biochemistry Mission). I believe that my goals in teaching and scholarship align with this mission statement as well as the first two points from *Becoming BYU*: "Strengthen the Student Experience" and "Focus on Undergraduate Teaching". My citizenship goals are in line with the department's emphasis to strengthen our graduate program. I also believe that creating stronger connections to nearby universities and participation in scientific societies provides opportunities to "Promote BYU's Double Heritage" by demonstrating our dual commitment to scientific learning and the Gospel of Jesus Christ. Our department aims to attract more Latter-day Saint graduate students that can help strengthen our community and undergraduate students.

D. Resources needed

My department has provided a good laboratory space and ample startup funds for my research. Additionally, I have an exceptional mentor that meets with me regularly. My first teaching assignment was set up in such a way that it was virtually impossible for me to fail. Another experienced professor was teaching another section of the same course during the same semester. He provided me with all his materials and coached me through the entire semester. Every other professor that I have interacted with in my department has readily answered my questions and given sound advice and encouragement. The one resource that I lack is experience

in my research group; however, I expected this challenge because of the technical nature of my research.

E. Activities and accomplishments toward goals

I. Teaching

- Chem 227
  - Successfully taught in Fall 2024 with updated mass spectrometry information
  - Working with co-instructor to adjust the course homework and midterm exam structure
  - Making plans for long-term course improvement, including a change in overall structure
- Chem 629R – Mass Spectrometry
  - Currently teaching in Winter 2025
  - Implementing pre-class quizzes and in-class activities; will evaluate at end of semester

II. Scholarship

- Waiting for decision on NIH R35 grant proposal submitted last year
- Preparing to submit NIH R21 in February 2025
- First journal article as corresponding author with student first author published in *JASMS*
- Second journal article with student first author pre-print submitted to *Chemrxiv*; final publication in process for submission early this year
- Two other publications with student first authors in mid-stage preparation; two in early stage preparation
- Preparing students to submit applications to present at yearly ASMS Conference
- Accepted two new undergraduate research assistants with department/college funding

III. Citizenship

- Visited Utah Tech and SUU in October 2024 as representative of department graduate recruitment committee
- Preparing to co-chair workshop at ASMS conference in June 2025
- Accepted assignment to co-organize mass spectrometry sessions at SciX conference in October 2025
- Have reviewed three journal articles for *Analytical Chemistry* and one for *JASMS*

F. Mentoring

My main vehicle for mentoring will be my research group. I currently spend about four hours each day interacting directly with my group members; however, I am also encouraging more independence so that they are not relying on me to execute the experiments for them. I am trying to strike a good balance where they have opportunities to try new things and make mistakes without feeling abandoned or lost. When I teach, I emphasize my willingness to help students outside of class and respond promptly to emails. In large classes, I hope to develop a better ability to target students who need more help and attention so that they are not lost in the crowd.

G. Belonging

I had an interesting conversation with an international student who said that he sometimes struggled with feeling part of the BYU community, even though he participated in several groups. He said that he mostly connected with those who served missions speaking his native language, but not necessarily many others. I plan to include more opportunities for students to connect during in-class activities to hopefully create relationships that last beyond the semester. For

example, have students answer an ice-breaker question in small groups before working on an example problem together.

TEACHING PORTFOLIO

Semester Self-Evaluation for BYU Faculty

Instructor Name:

Department: Chemistry and Biochemistry

Semester/Term: Fall 2024

Courses Reviewed: Chem 227

Teaching that results in significant student learning is, and should be, the most important activity of university faculty. (BYU Rank and Status Policy, 3.2 Teaching)

Instructions: Provide evidence from multiple sources (e.g., student performance on exams and projects, student ratings, student comments, formative evaluations from peers and/or students, self-evaluations) relative to the *Three Pillars of Effective Teaching*. Include evaluative statements regarding areas of strength, areas for improvement, and action plans.

Past Semester

Processes of Improvement (current) Ctrl-click for Guiding Questions for Processes of Improvement

Describe actions taken and how they affected student learning and/or the learning environment. Include appropriate evidence.

This class is normally co-taught by two professors. Each is primarily responsible for one section. Both sections attend the same lecture period together with both professors, and each section attends a laboratory section with the assigned professor for that section. I scheduled a weekly meeting with my co-instructor so that I could learn the structure and flow of the course and be prepared for my parts in the lecture portion.

I mostly used the lecture slides given to me by my co-instructor; however, I did make changes as I felt inspired. In one lecture, I created some animations to demonstrate a principle more clearly, and in another, I completely reordered the slides and added some new questions and activities to make the presentation more active on the part of the students. My co-instructor was very happy with the changes to both lectures, and a few students told me afterwards that the restructured lecture was one of their favorites up to that point.

My research specialty was one of the final class topics and covered two days of lecture. I asked to cover both class periods and made my own presentations in an attempt to update what had been taught previously. My co-instructor had a mixed response. He liked my effort to update and restructure the material, but he felt that I had taught too much material at a higher than appropriate level. When I talked to a few students individually, they responded positively, but clearly had not fully understood what I taught. The majority did, however, perform well on the exam questions related to that material. I plan to adjust these lectures back to an appropriate level while keeping the updated material.

List additional professional development activities in which you engaged.

My co-instructor and I attended and presented at a college teaching seminar. We presented how we teach together as an example for other departments.

Student Learning Ctrl-click for Guiding Questions for Student Learning

Describe areas of strength with appropriate evidence.

The major evidence of student learning is the independent project lab assignment. For this lab, groups of students design an experiment that uses the instruments and techniques that they learned during the course. The professor consults with the students to ensure that the experiments are likely to produce useful results. All the groups came up with interesting projects, ranging from analyzing zinc content in sunscreen to comparing folic acid content in raw vs. cooked spinach. The second part of the lab, which acts as the “final exam” or cumulative experience for the class, is a written lab report. The teams of students have to organize and delegate, because they write one combined report. This activity simulates

a real research practice of multiple authors writing a collaborative research article and evaluates their ability to describe their experiment accurately and completely, present results in tables and graphs, discuss the meaning of their results, and provide a wholistic view of what questions or problems their experiment addressed. The following link is an example of an average high performing group of students: Student independent project report.

Describe areas for improvement based on evidence.

Although the lab portion of the class is very strong based on student performance, the classroom/lecture portion needs some improvement. The main piece of evidence is the midterm exam performance. The first midterm had an average of 76% and only two students achieved over 90%, whereas the second midterm had an average of 81% and only one student achieved over 90%. While these scores are not atypical for rigorous chemistry courses, a more detailed look at exam problems revealed several questions on which no students achieved full points and a couple of questions on which all students achieved low scores. These results indicate that some of the exam questions are not clear and/or students are not adequately prepared to address the questions.

In addition to performance on midterms, many students in their course reviews stated that the homework assignments were not a good learning experience. Part of the course is to teach students to use programming to analyze data and perform calculations; however, learning basic programming is only supported by an unrequired video tutorial. Students who have coding experience through other classes or other means do well at the homework, but the rest struggle and have a hard time getting the help needed during office hours. Because they are motivated, most students end up with good homework scores; however, their comments indicate that they do not feel like they know how to code and that the assignments were a burden.

Learning Environment Ctrl-click for Guiding Questions for Learning Environment

Describe areas of strength with appropriate evidence

The laboratory portion of the course in very active, and students clearly learn the most while doing experiments. I always tried to help students work through their problems without telling them what to do and most responded well to that approach. The schedule was purposefully designed to give students plenty of time to try, fail, and try again on each experiment with additional time to receive help from instructors and TAs when preparing their reports. For me, this was the best time to talk with students individually and address their concerns. Because I spent six hours each week in lab with them, I was able to know them individually and talk with them about topics beyond the course, such as graduate school, industry vs. academic careers, and so on.

Describe areas for improvement based on evidence.

Gospel methodology was the main environmental factor that I felt was lacking in the course. I tried to include spiritual thoughts during the lectures that I gave, but the pacing of the class was restrictive. I believe this is an important and unique part of a BYU education, so I plan to discuss with my co-instructor how we can better include some simple means to include gospel aspects in the course.

Next Semester

Processes of Improvement (future) Ctrl-click for Guiding Questions for Processes of Improvement

Prioritize possible actions and select a feasible set that you plan to undertake and report on next semester.

Overall, the nature of this course a fast-paced lecture-laboratory hybrid creates some challenges that I want to address. One challenge and benefit is the co-instruction. I have ideas to propose, but my co-instructor needs to agree with them. This creates a good check-and-balance but also limits what I can do on my own. We plan to meet weekly during the winter semester when Chem 227 is not offered to begin to restructure aspects of the course. I hope to address students' concerns with the midterm exams and homework assignments. Primarily, I want to write exams and assignments that are more cohesive with each other and the rest of the course.

Guiding Questions for Student Learning

return to Student Learning

Learning Outcomes

- Are the course learning outcomes clear, appropriate to the course, and consistent with program outcomes?
- Do the learning outcomes reflect the Aims of a BYU Education?
- Are learning outcomes effectively communicated to students?
- Is the course well-organized?

Learning Activities

- Are learning activities well-designed and appropriate to the course?
- Do learning activities appropriately incorporate gospel methodology, concepts, and insights?
- Do the learning activities promote student engagement?
- Do the learning activities effectively facilitate the achievement of learning outcomes?

Learning Assessment

- Are assessment instruments aligned with learning outcomes?
- Are assessments effective measures of student learning?
- How well are students achieving the learning outcomes?

Guiding Questions for the Learning Environment

return to Learning Environment

Relationships

- Does the instructor integrate faith into the course and inspire students in their learning?
- Are instructor-student interactions appropriate, respectful, inclusive, and motivating to students?
- Does the instructor foster positive and supportive student-student interactions and ensure respectful discussions of challenging issues?

Settings

- Does the instructor use the classroom, lab, studio, etc. to create an effective setting for inspiring learning?
- Does the instructor create an atmosphere that motivates students to be active and engaged learners?
- Does the instructor create an atmosphere of civility and respect that welcomes diversity, promotes equity, and invites belonging for all students, regardless of their race, gender, sexual orientation, or other distinguishing feature?
- Does the instructor make reasonable efforts to make learning opportunities accessible to students with differing needs (e.g., physical, psychological, situational, technological)?

Materials & Other Resources

- Are course materials current and appropriate for the course?
- Are course materials used effectively to facilitate learning?
- Where appropriate, do course materials reflect a diversity of sources and perspectives (e.g., gender, race, ethnicity, culture)?

Guiding Questions for Processes of Improvement

return to Processes of Improvement

Course Improvement

- Are assessment data and other sources of evidence effectively and consistently used to improve the learning outcomes, learning environment, activities, and assessments?
- Do these improvements lead to increased achievement of learning outcomes?

Professional Development

- Does the instructor engage in regular self-evaluation of their own teaching?
- Does the instructor participate in activities (e.g., consultations, seminars, courses, study of pedagogy literature) that help them learn and develop as an instructor?
- Does the instructor implement best practices, and have they assessed the impacts of those practices?

SCHOLARSHIP DEVELOPMENT PROJECT – FINAL REPORT

Chemistry & Biochemistry
February 2025

A. Evaluation of goals

1. Help every student prepare a research article manuscript

This goal was ambitious. I did publish an article through a collaboration with my colleague and his student; however, my students' projects were still at an early stage by December last year. Currently, one student is finishing data analysis while simultaneously preparing a manuscript draft, so I plan to attempt this goal again by December 2025.

2. Submit a NIH R21 grant proposal (due in October)

I had a proposal ready by October, but a research development advisor was worried that my proposal was not aligned with the solicitation. I decided to rework the application based on the feedback I received and am now in the process of applying for the February 2025 deadline.

3. Review comments from previously submitted NIH R35 proposal and potentially prepare a second submission

I reviewed the comments and applied some of the suggestions when preparing my R21 application; however, I have not yet begun to prepare a second submission. I have not received a final decision yet on my R35 application.

B. Evaluation of strategies for productivity

1. Establish a weekly schedule that includes regular times for writing, reading research articles, and performing experiments.

I successfully established a habit of writing 4–5 days per week for about 30–60 minutes. This helped me in preparing a grant proposal ahead of the deadline, as well as write peer reviews for articles and submit two articles. Because my students are performing their own experiments now, I have mostly relied on them to ask me for help in the lab. Reading current research is my weakest area, so I need to plan time to read a few articles each week.

2. Continue monthly meetings (with additional as needed) with my faculty mentor who has a successful, externally funded research program

My mentor and I have continued our monthly lunch meetings. We discuss strategies and practices for successful teaching and research.

3. Investigate more opportunities for collaborative projects

I have mainly focused on getting my students to be more independent and productive; however, I connected with other scientists at conferences and had productive call meetings with them. I plan to leverage these relationships for external collaborations.

C. Evaluation of Scholarship structure (from FDP)

I believe my overall structure will lead to long-term productivity in the forms of intellectual output and student development. My main focus is to help my students drive the research forward in a

positive feedback loop, where student success improves the quality of research and the quality of research fosters student success.

D. Lessons from this process

I learned that regular habits lead to achieving goals. The goals I reached were those that I remembered constantly and worked on daily or weekly. I plan to continue improving my scheduling of regular activities so that I make progress on multiple goals simultaneously, rather than trying to complete goals sequentially. For me, this is important, because I tend to have multiple coinciding deadlines. When I have tried to start and complete a large task in one sitting, I usually hit a point of fatigue leading to decreasing productivity. When I spend a fixed amount of time on multiple tasks, I usually make good progress on every task and feel less overwhelmed.

TEACHING GRANT REQUEST

Chemistry & Biochemistry
February 2025

The experiences provided in laboratory chemistry courses are always dependent on the available equipment. This is especially true for Chemistry 227, which is an introductory analytical chemistry course. In this course, students learn the fundamental principles of common analytical tools and instruments in class and then practice operating them during lab. The combination of theory and practice gives students a valuable learning experience that they would not have without access to these tools.

Currently, students use class A glass pipettes to prepare their solutions for analysis. Although these are excellent pieces of glassware, they are not widely used in industry, government, or academic labs. Modern analytical labs typically use mechanical pipettes that are operated differently than glass pipettes. To provide students the opportunity to learn how to operate these more advanced pipettes, I am requesting this teaching grant to purchase a set for the Chem 227 lab section.