Faculty Development Plan

Introduction

Personal Statement: I am excited to be a faculty member at Brigham Young University. Having grown up in a remote corner of Arkansas with a sparse LDS population, I appreciate the unique environment that BYU provides to young LDS scholars at a critical time of life. I wholeheartedly support the mission of BYU; I hope to help many of Heavenly Father's children gain a rigorous education that is intellectually enlarging, character building, and spiritually strengthening so they can go forth and serve as pillars of moral strength and productivity throughout the world.

As the professional research professor in charge of the X-ray diffraction (XRD) facilities in the Department of Chemistry & Biochemistry, my primary responsibilities are (1) to support research by managing the XRD laboratory (professional service), (2) to teach chemistry classes in related areas, and (3) to carry the same citizenship responsibilities as all other faculty members. In this document, I provide my personal blueprint for fulfilling these responsibilities. For each of the three areas, I outline my department's specific expectations, assess my strengths & areas for potential improvement, present both long- and short-term goals as well as steps for accomplishing them, note the resources required, and describe any activities thus far in achieving these goals.

Professional Service

Department Expectations

My primary responsibility is to supervise the XRD facilities in the Department of Chemistry and Biochemistry. Specific duties for this professional service as outlined in my position description include

- collecting and analyzing XRD data for and in collaboration with faculty and their students;
- assisting faculty to put structural information in the proper form for publication;
- maintaining the XRD equipment, keeping the diffractometer and accessories in proper and safe operating condition (when maintenance and/or repairs fall outside of my expertise, technical personnel may be used after consultation with the chair or associate chair);
- being informed of new instrumentation, software, etc. that become available and making recommendations for upgrading or purchasing instrumentation or software as needed;
- taking the lead in writing proposals to fund purchases of new instrumentation;
- and periodically teaching principles of XRD in undergraduate and graduate classes and giving related classroom presentations when requested.

While I am not required to conduct an independent research program (though I may do so with the consent of the department chair), I am expected to participate vigorously in activities to improve my skills, improve the XRD facilities, and to collaborate with faculty colleagues as requested. My performance in maintaining and improving the XRD facilities and on meeting the structural analysis needs of the faculty and students will be assessed by my faculty colleagues (see the Comments section below for suggestions on service crystallography expectations).

Self-assessment

Strengths

I have experience in numerous structural analysis methods including powder XRD, small molecule SC-XRD, synchrotron X-ray techniques such as PDF & EXAFS analyses, and thin film diffraction and scattering techniques. Such a broad range of expertise is unusual, and though the position into which I was hired was targeted solely at someone with
small molecule SC-XRD experience, I intend to harness all of these skills to enhance and increase structural analysis research at BYU.

I am an effective collaborator, accustomed to working with others of a range of personalities and professional backgrounds. This should enable me to succeed in my role as a service crystallographer, which requires that I work continually and congenially with all others in the department and the university.

I am an effective communicator. This should enable me to assist users of the facility at all stages of the scientific process including minimizing training time, providing clear instruction during data collection and analysis, and assisting users in communicating their results lucidly and succinctly. As a skilled writer, I anticipate being of assistance in the preparation of manuscripts for publication as well.

Areas for development
The nature of my position will require me to juggle a multitude of research projects simultaneously. Further developing my time management skills as well as my communication skills will be essential. In fact, learning how to balance my time between my three major areas of responsibility (research, teaching, and citizenship) will likely be my greatest challenge and area for development.

Goals
Below I list my overarching goals for running the XRD facility (in line with department expectations) followed by specific steps for accomplishing these goals.

(1) Assist researchers (primarily in the chemistry department but also throughout the university as time permits) with all aspects of X-ray diffraction experiments including collecting XRD data, performing structural analyses, and helping format the resulting information for presentation and publication. In many cases, this means I will act as a service crystallographer, performing all of these functions myself. I intend to do so in a timely fashion to the satisfaction of the groups involved.

To facilitate this for the single crystal X-ray diffraction (SC-XRD) instrument, I will

a. create sample submission forms (providing me with necessary sample information as well as a means of tracking submitted samples),

b. create a logbook with forms containing the history of each sample so that I (and others) can see at a glance what was done and when,

c. maintain consistent communication with groups
   a. potentially creating an online site through chem.byu.edu for status updates and/or for sharing/receiving the final results,

d. carry all requested refinements/analyses to completion in a timely manner (within a few days or weeks for difficult structures) and ensure that the structures are ready for publication (i.e. pass CheckCIF) before giving the pertinent files to the groups,

e. and assist groups with publication materials including writing the experimental details, providing requested input for the discussion of the results, helping to create figures, and generating tables for supplemental information.

Similarly, for the powder X-ray diffraction (P-XRD) instrument, I will

f. create sample submission forms for those requesting me to act as a service crystallographer,

g. create a logbook with sample history forms for these samples,

h. maintain consistent communication with groups,

i. carry all requested analyses to completion in a timely manner,

j. assist groups with publication materials.

(2) Maintain the P-XRD and SC-XRD instruments in good working order with the help of personnel from the department support facilities as well as specialized technicians when repairs fall outside my expertise.

For the SC-XRD, this will entail

a. overseeing the necessary repairs to make the instrument functional with all safety interlocks in place,

b. directing the building and installation of new server & client computers to run the instrument,

c. updating all software and gaining access to necessary databases,
d. cleaning out the SC-XRD laboratory and ordering new/necessary supplies,
e. and placing the instrument under a full service contract for at least 3 years.
   1. I will attempt to learn essential instrument maintenance techniques from the technicians each time
      a service call is made so that (if I deem it feasible) we may transition to a lower level service
      contract or to independently maintaining the instrument.

For the P-XRD, I will

f. create an annual maintenance schedule for the hardware that needs regular maintenance,
g. instigate monthly checks on the X-ray tube intensity to track performance and project tube replacement,
h. keep the P-XRD lab clean and organized,
i. and keep the instrument under full service contract for the first three years, trying to learn essential
   instrument maintenance techniques from the technicians so that (if I deem it feasible) we may transition to
   a lower level service contract or independently maintaining the instrument.

For both instruments, I will try to resolve maintenance issues as promptly as possible to keep the facility working
at maximum capacity.

(3) Make recommendations for upgrading or purchasing instrumentation as needed. To do so, I will
a. stay informed about the cutting edge instrumentation and software available by annually attending
   crystallography conferences and staying in contact with the major vendors of XRD equipment,
b. and take the lead in writing proposals for funding the purchase of new XRD equipment that cannot
   feasibly be covered by the departmental or college capital equipment funds.

(4) Increase awareness and usage of the XRD facility both within the department and the university. To accomplish
this, I intend to
a. give a department seminar about the XRD capabilities here at BYU once the instruments are fully
   functional;
b. give talks about XRD outside the department:
c. give small presentations to specific interest groups or group meetings;
d. post information about interesting projects/capabilities on the bulletin board outside the XRD lab;
e. set up a list serve email group to dispatch regular updates about the status of the facility;
f. create (and keep up-to-date) a page on the chemistry website containing information about the XRD
   facilities as well as any sample submission forms, policies, educational materials, useful links, etc.;
g. and post information about current/recent/interesting XRD projects on my faculty website.

(5) Train students and researchers to collect data and do XRD analyses themselves. This is a long-term and somewhat
daunting goal because students receive essentially no training in crystallographic theory or practice in our current
curriculum; only senior undergraduate chemistry majors taking the Chem 518 lab class in their last semester at
BYU are exposed to any X-ray diffraction at all, and this exposure is minimal (largely hands-off) and qualitative.
Thus, in general, the graduate and undergraduate researchers needing to use the facilities have no exposure to X-
ray diffraction, and training must start from the ground up.

For the P-XRD, students can relatively quickly (through several hours of training over several days’ time) be
trained to operate the basic functions of the instrument and perform qualitative analyses themselves. Prior to my
arrival, students generally ‘trained’ other students in their groups in these areas. Unfortunately, this has resulted in
the propagation of ignorance about and incorrect usage of the instrument as well as inaccurate analyses of XRD
data. To improve the situation, I intend to
a. re-train many students and perform all subsequent new trainings myself,
b. create a series of short, online tutorials that students must watch or read on their own to get up to speed on
   the basics of diffraction theory in order to gain access to the instrument
   i. (these materials could then be used as the starting point for a senior undergraduate and graduate
      level course in crystallography in which several faculty & students have expressed interest),
c. create an online X-ray safety training/tutorial along with a quiz and form to be turned in and kept on file
   before hands-on training with the instruments can begin,
d. figure out the best way to provide hands-on training with the instrument and analysis software
(perhaps instigating a week-long 'XRD boot-camp' in which I work with new users in small groups for a few hours each day to train them to perform basic qualitative analyses and operation of the instrument and to introduce them to options for more sophisticated quantitative analyses)
e. create improved written standard operating procedures (SOPs) that are easy for new users to follow but contain enough information to be of use for more experienced users,
f. and potentially train a series of graduate students to serve as TA's so researchers have more than one resource to go to with questions if when usage of the powder and single crystal facilities increases beyond the ability of 1 person to manage all aspects of equipment maintenance, user training, and assistance with data collection/analysis.

1. This will require selecting and training a new graduate student about every 2-3 years to be the designated 'XRD TA' (maybe a 5 hr/week assignment). This assignment will need to be for each semester over 3-4 years: without this level of dedication, the TA will be ineffective.

For the SC-XRD, I anticipate doing the majority of experiments myself, but there will hopefully be interested graduate (or extremely motivated undergraduate) researchers from groups that regularly use the instrument who will want to be trained.

a. Eventually, I want to teach a graduate/senior-undergraduate level course on crystallography (including a lab component) that will introduce the theory and practice behind both powder and single crystal XRD.
b. Until then, I will use the online trainings generated for the powder XRD to introduce interested students to the basic theory of XRD.
c. These students will also be required to complete the online X-ray safety training/tutorial along with a quiz and form to be turned in and kept on file before hands-on training with the instruments can begin.
d. Each time the students have a sample to run, I will work with them one-on-one or in very small groups, guiding them through the entire sample preparation, data collection, structure solution, and refinement processes until they can comfortably performs these tasks on their own (which will likely be after they have completed at least 5-10 samples). Even then, I will likely be heavily involved in the refinement process at minimum.
e. I plan to generate written materials over time to serve as references/guides for users and as an SOP for the lab component of the class I hope to teach.

I intend the P-XRD facility to be primarily a user facility, but the SC-XRD facility will likely remain primarily a service facility.

(6) Contribute to the proposals and manuscripts of faculty colleagues (as requested) to bolster their efforts in obtaining funding.

a. I intend to keep in regular contact (checking in at least annually) with previous, current, and potential users of the XRD facility to discuss their projects/proposals and to remind them of the resources available.

(7) Continue gaining exposure to and experience with various techniques and analysis methods. To do this, I will

a. spend at least 1 hour each week researching an XRD topic, analysis method, or practice;
b. attend annual crystallography conferences, networking with peers in the field;
c. and participate in educational webinars on XRD techniques and topics.

(8) Gain experience with macromolecular/protein crystallography so that I may assist biochemists hoping to do structural analyses. This is a long-term goal that will likely require leave for professional development.

Resources needed

Funds

to repair, replace, or upgrade instrumentation and software
to pay annual fees for the necessary databases (ICDD, CSD, and potentially others)
for me to travel to ACA and IUCr conferences (and potentially occasional ACS conferences) to stay current in crystallographic equipment, software, and methods
for me to occasionally attend trainings on new equipment & methods (potentially) for me to create effective training materials
for a student assistant as described in goal5f

Time

Unlike other facilities, the XRD facility is largely a service-based facility, meaning I perform all aspects of the majority of experiments and analyses. Thus, in addition to maintenance and training duties, I require larger amounts of time to actually perform the research to fulfill my professional service duties.

The maintenance of the two instruments in the XRD facility differ widely, requiring me to interface with Completely difference companies/technicians/etc. which also takes significant amounts of time.

I am simply making department leadership aware of these time demands as they consider other assignments.

Activities thus far

(1) So far in 2014 for the SC-XRD instrument (January 1 - August 6), I have assisted researchers with 25 crystal structures, 19 of them studied using our own instrument since its repairs were (essentially) completed in mid- June. (Due to the length of time necessary for the repairs on our instrument, the data for the first 6 structures were collected by my contacts either at MIT or through the SCrALS program.) 9 of these structures were of significant interest for their refinements to be carried to completion, typically within a week or two of the data collection. In addition to this rather significant achievement (see comments section below),

- a. I have created sample submission forms and have implemented a queue system for sample submission so that users and I can see at a glance what samples are waiting analysis;
- b. I have created a logbook with forms in which I record the history of each sample;
- c. I have maintained consistent communication with the groups (mainly those of Roger Harrison, David Michaelis, and Dan Ess) about the status of their samples;
- d. I have carried all requested refinements/analyses to completion in a timely manner (within a few days or weeks for difficult structures), ensuring that the structures are ready for publication (i.e. pass CheckCIF);
- e. for each of the finished refinements, I have emailed the groups with publication materials including experimental details, data tables for supplemental information, requested input for the discussion of the results, and any figures requested;
- f. and I have also assisted users in viewing their structures, introducing them to the freely-downloadable Mercury program and assisting them with any questions on its usage.

So far in 2013-2014 for the P-XRD instrument, I have acted as the service crystallographer for the following 13 projects, have trained or retrained 10 student researchers, and have assisted most users of the instrument with one or more questions/issues about their experiments or problems with their analyses.

- a. Matt Linford: quantitative X-ray reflectivity (XRR) analyses of Bi-Te-Se films. I have also been heavily involved in preparing the manuscript containing these analyses.
- b. Matt Linford: quantitative particle size analysis of 9 diamond nanoparticle samples
- c. Tracy Nielson (Mechanical Engineering Department): quantitative Rietveld analysis of a friction stir welding sample, quantifying the fcc, bcc, and tetragonal phases present
- d. Jaron Hansen: identifying an unknown crystalline powder from a reactor
- e. Jaron Hansen: comparison of zeolite samples
- f. Roger Harrison: high temperature in situ analysis of ZnO nanoparticles, quantifying particle size as a function of calcination temperature
- g. Aaron Hawkins (Electrical and Computer Engineering Department): high temperature in situ analysis of silica waveguides
- h. Richard Watt: analysis of various photo reduction samples, showing HgCl to consistently be the product. Helped David work out a hypothesis involving surface HgO (orange) turning to HO (gray) as reduction proceeds to explain the visual differences in the samples.
- i. Richard Watt: attempting a capillary XRD experiment with ferritin-encapsulated nanoparticles in solution
- j. Karine Chesnel (Department of Physics & Astronomy): analysis of iron oxide phases and particle sizes
- k. Matt Linford: qualitative analyses of Si-coated carbon nanotube forests deposited on Si wafers
- l. Bill Hecker (Chemical Engineering Department): helping graduate student Kamyar Keyvanloo analyze XRD data for his Fe/Co/Ah03 catalysts and figure out better instrument settings for his experiments m.
- Doug Johnson (Geology MS student): comparison of geological samples
(2) I have maintained the P-XRD and overseen/performed repairs on the SC-XRD instrument so that both instruments are now in good working order. For both instruments, I have resolved maintenance issues as promptly as possible to keep the facility working at maximum capacity.

For the SC-XRD, this has involved working with numerous Bruker technicians to coordinate and/or perform the necessary repairs and upgrades. After the initial Bruker service call mid November 2013, I switched and tested various combinations of the new and old anode motor and tube control boards myself and determined by early December which parts needed to be replaced. I regularly checked in with Bruker between Nov-May about the repair of the detector that we discovered was necessary during the first service call. I reinstalled the detector (with the help of the Bruker technician in a second service call) within 2 weeks after Fairchild finished replacing the CCD chip. I installed the new vacuum gauge the day after it arrived (trouble-shooting the initial issues with the help of Jim Armstrong in the instrument repair shop).

Outlining how I have met some of the specific goals mentioned above for the SC-XRD, I

a. oversaw the necessary repairs to make the instrument functional with all safety interlocks in place including replacing the anode, replacing the cathode filament, greasing the gears, realigning the instrument, testing/replacing the tube control boards, testing/replacing the anode motor, repairing/reinstalling detector, and replacing the vacuum gauge;

b. directed the building and installation of new server & client computers (during the downtime necessitated by the repair of the detector) with the help of James (student worker) in the CSR office and Scott Phillips (Bruker technician) through web-ex;

c. updated all software with the help of the Scott Phillips (again through web-ex);

d. cleaned out and reorganized the majority of the SC-XRD lab, ordering multiple new supplies (e.g. reusable magnetic goniometer bases with cryovials, MiTiGen sample mounts, oil can, needles and a pm vice grip for manipulating crystals during sample mounting);

e. and I will place the instrument under a full service contract for 3 years once the last service call and vacuum gauge billings are closed.

1. I have taken copious notes during both service calls during the last year. However, at this point, it still seems cost effective to maintain some level of service contract rather than relying on myself and the instrument repair shop to maintain this highly specialized equipment.

For the P-XRD, this has involved working with several PANalytical technicians (in person and over the phone) to coordinate and perform the necessary repairs. So far this year, I have replaced the motor and gear of the sample spinner (with help from a PANalytical technician) within 2 weeks of when it ceased to work in May 2014, coordinated the semi-annual service call with the replacement of the X-ray tube and helped the technician with this replacement/realignment in June 2014, and replaced the water flow gauge on the high temperature stage (with help from Jim Armstrong) the week after it arrived in June 2014. I have also resolved the numerous glitches with the ICDD database (typically within 1 week of their occurrence).

Outlining how I have met specific goals mentioned above for the P-XRD, I

f. have created an annual maintenance schedule for the hardware that needs regular maintenance;

g. have initiated a set of monthly checks on the X-ray tube intensity, instrument alignment, equipment, and software since the tube replacement in June

1. (generating written instructions for student TA's to use in the future);

h. and have the instrument under full service contract.

1. I have been learning the essential instrument maintenance techniques from the technicians so that it may be feasible to transition to a lower level service contract eventually.

(3) Two notable instances of recommending instrument upgrades/acquisitions during my first year include the following:

a. When I arrived in Sept. 2013, I recommended to the department chair that we switch the rotating anode X-ray source on the SC-XRD instrument to a new microfocus system which would require much less power and cost much less to maintain (there are no moving parts) while still delivering close to the same signal. The quoted price received from Bruker at the end of September to convert the system ($160,000) was unfeasible for the dept/college budget at the time, however, so I scheduled the repairs necessary for the rotating anode system (the first available time for a technician able to work with our system being mid-November).
b. Through my talk given at the college Speed Networking Event in August 2013, I discovered much interest on campus in thin film XRD capabilities (at least 10 groups in the CPMS and College of Engineering). Our current XRD instrumentation cannot accommodate these analyses, so I took the lead in writing an NSF Major Research Instrumentation (MRI) grant proposal submitted in January 2014 requesting funds (roughly $250,000) for the purchase of a new thin film X-ray diffractometer. Co-PI's included Matt Linford (chemistry), Steve Turley (physics), Karine Chesnel (physics), and Aaron Hawkins (ECEn) with the research of James Patterson (chemistry) and Daniel Smalley (ECEn) also included. This proposal was recently declined, but received positive reviews from 2 of the 3 reviewers.

(4) I am slowly increasing awareness and usage of the XRD facility both within the department and the university. Thus far I have
a. given a talk about XRD outside the department at the August 2013 CPMS Speed Networking meeting
b. and given small presentations about XRD to specific interest groups or group meetings including those of the Nano Materials Interest Group (Jan. 13, 2014), the Spectroscopy Club (Nov. 22, 2013), and several of Matt Linford's group meetings in September 2013;

(5) So far this year I have trained or re-trained (generally in individual sessions lasting at least 2 hours and typically with multiple follow-up trainings) at least 10 student researchers from 7 groups on the P-XRD (Harrison (2), Lamb (1), Patterson (1), Woodfield (3), Watt (1), Hecker (Engineering) (1), Ess (1)). I have also begun making an outline of topics for the online trainings I intend to create as part of my faculty development projects.

(6) Thus far I have assisted with or answered questions for the proposals of Josh Price, Steve Castle, and Brian Woodfield.

(7) I have continued to gain exposure to various techniques and analysis methods. Since Spring 2014, I have
a. spent roughly 1 hour each week researching an XRD topic, analysis method, or practice including chiral space groups, procedures for dealing with twinned structures, background modeling techniques for P-XRD, and changing pulse height detection limits on our X'Celerator P-XRD detector to compensate for fluorescence backgrounds;

b. and attended the annual ACA conference, networking with peers in the field;
c. and participated in several educational webinars on XRD techniques and topics.

(8) Through networking at the 2014 ACA conference, I met several scientists (Banu Sankaran and Christine Beavers) at the ALS who assist novices with macromolecular crystallography through a new program called Collaborative Crystallography. I was able to connect Banu with Steve Castle to assist him both with his proposal on peptide research and eventually with the actual sample preparation, data collection, and analyses later on.

Comments

**Division of Time.** My position has been consistently described to me as half research, half teaching. I have noticed this includes no time allotment for citizenship responsibilities, so I presume the percentages should be amended to something more like 40-45% research, 40-45% teaching, and 10-15% citizenship.

**Service crystallography expectations.** Most full-time service crystallographers run *either* a powder or a single crystal XRD facility; it is uncommon for one crystallographer to have sole responsibility over both, as I do here at BYU. Additionally, most service crystallographers have no teaching assignments beyond an annual course on X-ray diffraction theory/practice intended to train users of the facilities. Because I run both powder and single crystal XRD facilities and am to spend roughly 55-60% of my time on other teaching and citizenship responsibilities, I can realistically spend roughly 20-25% of my time on each XRD technique. Thus, a reasonable expectation for the SC-XRD facility would be for me to analyze roughly 20-25 small molecule single crystal structures per year, or roughly ¾ of the crystal structures that one full-time staff service crystallographer (with 1 instrument) can analyze per year (based on estimates from my contacts in the American Crystallographic Association [ACA]).

**A unique facility.** There are some important fundamental differences between the XRD facility and other facilities that bear consideration.
In the current chemistry curriculum, students receive no training on XRD theory or practice. The following are several consequences of this:

- There is not a large, ready-made group of users for the XRD facility. I have to recruit and train all users essentially individually.
- Student researchers enter my lab completely ignorant of what XRD is, much less how to do it. All XRD training is therefore done outside of any classroom experience.
- XRD training is much more invasive than for most other facilities, taking much more time/effort (for both me and the students).
  - From my experience with SC-XRD training at MIT, students typically require an in-depth, 1-2 semester class on diffraction theory as well as hands-on, one-on-one training with at least 5-10 samples (so 5-10 weeks of hands-on experience) before they can begin to perform experiments somewhat independently.
  - From my experience with P-XRD training here at BYU, students typically require an initial 2-3 hour training on the most basic functions of the hardware and software followed by several more hours of one-one guided usage on at least 2-3 samples before they can begin to independently perform the most basic, qualitative experiments. At that point, they are still using the instrument much like a black-box. To become a proficient and truly independent researcher (performing any of the more quantitative or sophisticated P-XRD experiments), training times and requirements become similar to those of the SC-XRD.
  - Training times are thus most similar to those of the TEM (transmission electron microscope) facility than any other facility of which I am aware.

Many other facilities are nearly entirely user-based whereas the XRD facility is largely service-based. This means that most of the experiments in other facilities are run by the researchers themselves whereas all SC-XRD experiments are performed by me (including all aspects of these experiments such as sample preparation/mounting, data collection, structure solution, refinement, write-up of the data, and generation of figures/tables/information for publication). I also act as the service crystallographer for a significant number of groups/experiments on the P-XRD (for example, for all infrequent users and for all of the more sophisticated quantitative, high temperature, or capillary experiments) though regular users are trained to perform basic, qualitative experiments/analyses. The demands on my time per XRD experiment are thus widely different than in other facilities.

The XRD facility supports not only 2 different instruments but 2 completely different techniques; the samples, procedures, analyses, software, etc. used for the powder and single crystal XRD instruments/techniques are completely different, as is their maintenance. Running/maintaining both of them is more similar to running/maintaining both an SEM (scanning electron microscope) and a TEM (transmission electron microscope).

**Professional Research Faculty.** My position is as a professional research faculty, but I perceive that my responsibilities are sometimes confused with those of the more numerous professional teaching faculty in the department; I sometimes sense that I am expected to hold more teaching responsibilities (or be more adept at filling them) than professorial faculty. However, because I am setting up/running/maintaining two different labs (P-XRD and SC-XRD), am involved in numerous and widely varied research projects, and train/interact with many student researchers every year, I actually have research, teaching, and citizenship responsibilities and time demands more similar to professorial faculty.
Teaching

Department Expectations

My specific teaching duties as outlined in my position description include

- dedicating up to 50% of effort to teaching, mentoring, supporting structural content for classes, and carrying appropriate teaching assignments as designated by the department chair.

My original expectation was thus to dedicate up to 50% of my time (or 40-45% after considering citizenship responsibilities) to teaching and mentoring activities including training student researchers in and out of class (mostly outside of class), helping students with advanced course projects in the department, providing XRD content for classes, and holding other teaching assignments as designated by the department chair.

Through numerous discussions over the last year, however, I have been informed that (somewhat contrary to these stipulations) the department expectation for my teaching responsibility is this: because professional teaching faculty teach roughly 6 classes/year on average, the ‘50% of effort’ clause dictates that I teach roughly 3 classes/year on average. For example, during my first year, I taught Chem 495 (1.0 credits), Chem 594 (0.5 credits), and two Chem 105 classes (two 4 credit classes, 250 student capacity in each). By this interpretation, I will be dedicating 50% of my time to non-XRD-related teaching/mentoring. If this is what is needed by the department, I am happy to do so. The expectations for my other training/mentoring, professional service, and citizenship duties just need to be appropriately curtailed/amended in the future.

My performance in teaching will be assessed largely using peer and student evaluations.

Self-assessment

Strengths

I have a genuine love for learning and an enthusiasm for science that I try to infuse into my lectures to help students feel the same. I am a skilled presenter, typically with well-organized content presented in a logical, flowing, and (hopefully) interesting way. I feel I am able to break down difficult concepts and explain them effectively to people with a wide range of backgrounds or levels of knowledge. The majority of students find me approachable and approachable; my office hours were fairly busy, with most students reporting positive interactions.

Areas for development

Through valuable feedback from students and my mentor Jeff Macedone after my first year of teaching, I have identified several areas in which my teaching could be improved:

- Better alignment between course activities and assessments
- Identifying material to be covered in class and material that students can be responsible for learning on their own outside of class so that lectures are more focused and do not seem packed/rushed
- Not talking too fast and remembering to pause for reflection and questions
- Encouraging class participation; leading more discussions rather than relying solely on presentation
- Working more problems (or working them more thoroughly) in class

Goals

1. Read 1 book during the next year on improving college teaching and implement at least 1 idea from that book
2. Improve my Chem 105 course design using the learning outcomes approach:
   a. create specific learning outcomes (in line with those defined by the department for Chem 105)
   b. generate a list of necessary skills/topics to be learned in Chem 105
   c. create assessments to test the acquisition of these skills and the other desired course outcomes
   d. write homework assignments to help students acquire these skills, meet the outcomes, and prepare for the assessments
l. have a combination of short/regular online homework assignments, group work in recitations, more difficult weekly assignments, hands-on exploratory lab experiments and/or writing assignments, and practice tests (weekly or at least before each test)
e. redesign recitations to provide more effective group work and to use the TA's more effectively
f. design lectures to provide more significant/poignant learning experiences
   1. begin classes with a prayer
   ii. perhaps prime students before class with a cliff-hanger or other attention grabbing question to be answered/discussed during class
   iii. have at least 1 example every day of how the day's topic is relevant to everyday life
   iv. include more demonstrations
   v. work more problems thoroughly in class (not just having the steps on slides to be studied later)
v1. make better use of iClicker questions
   1. use them as a formative tool instead of an assessment tool
   2. use them to generate more in-class discussion
   3. have 3-6 questions/day, spread throughout the lecture
(3) Improve Chem 495/594R
   a. Improve the instructions in the syllabus so students better understand the goals/expectations of the course
   b. Incorporate a permission form to ensure that written work is handed back in accordance with FERPA regulations
   c. Grade and return written reports more promptly (within 1 week instead of 2-3)
(4) Support structural content for classes. Incorporate principles of X-ray diffraction theory/experimentation into several undergraduate and graduate classes to improve our students' exposure to this widely-used technique.
   a. Specifically, I will work with the faculty teaching Chem 518, Chem 455 & 555, Chem 581, and potentially Chem 5211523 and Chem 464/465 to introduce (or enhance/expand in the case of Chem 518) crystallography-related components for experiments currently performed in those classes and/or to tweak existing experiments to more readily include such components.
      i. First (during the 2014-2015 academic year), I plan to work with Roger Harrison to enhance/expand the XRD component(s) in the Chem 518 course, potentially adding some lecture content to Chem 514 if he deems it appropriate.
      u. Second, (potentially during the 2015-2016 academic year), I plan to work with Scott Burt and Matt Peterson (or whomever is the current instructor) to incorporate an XRD component into the Chem 455/555 classes.
   b. I will advocate that the chapter on solid state chemistry actually be taught in our introductory chemistry classes (Chem 105-106, 111-112) instead of being skipped, as is done currently.
      l. This will require shifting current curriculum outlines, and may require helping other professors come up with feasible yet not trivial homework and exam questions. Several have suggested having me give these lectures as a 'guest lecturer' in Chem 106.

Resources needed

Evaluations

from faculty peers,
from Ken Plummer from the Center for Teaching and Learning,
and from students both mid-semester and at the end of the semester to gauge the reception and effectiveness of specific teaching strategies and course procedures

Examples

It would be beneficial for me to continue (as I did Fall2013) observing other faculty members’ classroom teaching styles, gathering materials from them (lecture slides, homework problems, exam questions, etc.), and reviewing their course procedures to get ideas of how to improve my own teaching and course design.
**Time**

As mentioned in the Department Expectations section, the current interpretation of my teaching responsibilities (spending 50% of my time in non-XRD-related courses) leaves no time for goal #4, supporting structural content in various classes. If I am to develop XRD components for various classes, I must have time (at least 1 semester before) to think about how XRD experiments could be incorporated into the current curriculum without displacing much (if any) of the current content, test the various options, write instructional materials, and prepare lectures and other materials as necessary. Then, during the semester of the course, I must have sufficient time available to give any in-class lectures required, help students actually perform the hands-on experiments during the classes, analyze the data (with or without them), and help the students understand and incorporate the results in their reports. Unless these efforts are viewed as at least 1 of my 3 annual teaching assignments, I fear this goal will never come to fruition. Thus, the interpretation of how I spend the 40-50% of my time in teaching/mentoring needs to be revisited regularly as the needs of the department, the courses involved, and the demands of the XRD facility fluctuate/evolve.

**Activities & accomplishments thus far**

1. I have read the first 2 chapters of the book *Creating Significant Learning Experiences* by L. Dee Fink. I plan to make my lectures a more 'significant learning experience' by having at least 1 example of how the day's topic is relevant to everyday life in each class and perhaps by priming students before class with a cliff-hanger or other attention grabbing question to be answered/discussed during class. I also intend to provide students with more significant learning experiences by incorporating the exploratory lab into the assignment/homework structure.

2. I have begun to design my Summer 2015 Chem 105 course using the learning outcomes approach:
   a. I have created specific learning outcomes (in line with those defined by the department for Chem 105). To better meet the 'think like a scientist' outcome, I will be incorporating exploratory labs into the curriculum to connect classroom topics with physical objects, phenomenon, and everyday life.
   b. As a group, the department has generated a list of necessary topics/chapters to be learned in Chem 105 vs. Chern 106, and I created a day-to-day schedule in which the topics will be covered in Chem 105.
   c. I have redesigned the format of recitations for my Chern 105 class to have more effective group work and to utilize the TA's more effectively.
      1. I intend to have the TAs split their students into 5 groups at the beginning of the semester. I will write recitation assignments to have 5 challenging problems per recitation (10 per week). For the first 25 min of class, each group will start working on a different problem initially (when finished they can work on the other 4). Then during the second 25 min of class, each group will work their problem on the board in front of the class (5 min time limit), leading the class in working together to solve the problem. TA's will have already worked through the problems and so can help the various groups as needed and can guide the class discussions.
      1. 4 points per recitation: 1 point for attending the entire recitation, 1 point for participating in working the problem on the board with their group, 1 point for the work being correct, and 1 point for entering in all the correct answers online before midnight when the key becomes visible.
   d. I have generated a syllabus.

3. I have generated what I think are improved syllabi for Chem 495 and CChem 594, and I have generated a permission form so that student work can be handed back in public places (or alternate means devised if the student desires).

4. I have spoken with Roger Harrison, Scott Burt, and Matt Peterson about XRD components in the CChem 518, 455/555 classes. Roger and I have discussed plans to enhance the existing XRD component and to add additional XRD components/opportunities for other labs. I just need time to pursue and develop these ideas, as described above.
   a. I also prepared/presented 1 week of lectures to the Women in Science class taught through the Women's Studies major. This entailed two 1.5 hr lectures (March 10 and 12, 2014), one on women in chemistry and one on women in crystallography.
Citizenship

Department Expectations

My specific citizenship duties as outlined by my department include

- serving on department, college, and university committees when asked.

I am to carry the same citizenship expectations as all other members of the faculty. In addition to committee assignments, these responsibilities include participation in department faculty meetings and decisions, involvement in the university community, and involvement in the chemistry community at local, regional, national, and international levels.

Self-assessment

Strengths

I work well in groups and help push projects through to completion. I can be creative. I am skilled at planning and organizing events.

As a young female faculty in the sciences, I also have a unique perspective to offer. For the female half of our students, I can serve as one of the few examples of an LDS woman in science. I very much enjoy being involved in community outreach activities, and plan to continue to do so with an emphasis on encouraging women in science.

Areas for development or opportunities

When serving in leadership positions, I need to learn to delegate and coordinate instead of doing everything myself.

Goals

Department, College, & University Service

1. Fulfill all committee assignments
2. Be an active participant in all meetings, decisions, and governance activities
   a. Learn to speak up and share my unique perspective during department decisions & discussions (hiring, curriculum review/development, rank and status reviews, etc.)
3. Attend college networking events
4. Participate in department/college/university activities
   a. Attend/watch devotional each week
   b. Participate in graduation ceremonies annually
   c. Attend annual department/college awards banquets and other social gatherings
   d. Participate in chemistry week activities
5. Give XRD Lab tours when asked
   a. Prepare standard 10 min & 30 min presentations for different age ranges when these opportunities arise
   b. Have electronic example(s) of data/structures
   c. Have physical models to help illustrate diffraction phenomena

Broader Scholarly Service

6. Be involved in the broader crystallographic community, both nationally & internationally, to increase BYU’s visibility and credibility
   a. Continue to be an ACA (American Crystallographic Association) member
      i. Attend and present research results regularly at annual meetings
      ii. Participate in Special Interest Groups (SIGs)
      iii. Help organize and chair conference sessions
   b. Continue to be a part of the IUCr (International Union of Crystallographers)
      i. Attend meetings every 3 years, making contacts with international scientists
   c. Become well-connected with the Bruker, PANalytical, and Rigaku XRD equipment companies to aid/smooth instrument service and acquisition needs
1. Make & maintain contacts within each company
2. Participate in webinar series to keep current in the field
(7) Attend ACS (or other chemistry society) meetings occasionally
(8) Serve as a referee for peer reviewed publications involving chemistry and/or crystallography

Community Outreach
(9) Get involved in existing community outreach programs
(10) During fall semester 2013, I helped organize and orchestrate "STEM-out," a day of science fun at BYU targeted at middle-school aged girls in the region interested in STEM fields. By Fall 2016 I plan to develop STEM out into an annual event.
   a. Set up a budget and secure external annual sources of funding to meet it. (The funds for the original event in 2013 were through a one-time grant from NASA obtained by Denise Stephens in the Department of Physics & Astronomy.)
   b. Develop broad ranges of activities from all STEM fields and recruit female faculty from each area to help on a roughly annual basis
   c. Create more effective marketing and organizational tactics
      1. Set up a web presence and develop better sign up policies/procedures, advertising avenues, activity schedules, grouping procedures, etc.

Resources needed

Funds

sufficient budget allotment (after my first 3 years) to enable me to travel annually to the ACA conference and every third year to the IUCr conference

Support

To run the STEM out program, I will need access to lecture prep demos, some chemistry lab materials/rooms, and YChem students and grad students to be volunteer workers. The goal is to have the event fully sponsored externally, but if this is not feasible initially, I may ask for some additional department support.

Time

As previously discussed, my position description should be amended so that the division of my time includes a citizenship component (i.e. 40% research, 40% teaching, and 20% citizenship).

Activities & accomplishments thus far

(1) I have fulfilled all my committee assignments thus far, which include
   a. the Undergraduate Advisement Committee (freshman advisor)
      1. for which I answered questions during Freshman Orientation night, helped staff the chemistry booth at the career fair in Fall 2013, gave a presentation on active learning to the freshman during the chemistry majors advisement night in Winter 2014, and was available for 1-on-1 advisement appointments during the year
   b. the Graduate Recruiting Committee
      1. for which I gave seminars and recruiting presentations at UVU (Nov. 21, 2013) and the University of Utah (Jan. 9, 2014) and helped run the site visit in March 2014
         1. 2 students I interacted with from the University of Utah applied to our graduate program, at least 1 of which I know has been admitted for the fall 2014
   c. and the XRD committee.
(2) I have participated in all department governance meetings this year (including all hiring interviews, seminars, and faculty meetings and two rank/status reviews) and as many CCChem 105 textbook and curriculum meetings as my schedule would allow.
(3) I attended and presented at the August 2013 college networking event, and I plan to attend the August 2014 event.

(4) I have participated in numerous department/college/university activities
   a. Since the beginning of Spring term, I have attended or watched as many devotionals as possible.
   b. I participated in April graduation ceremonies.
   c. I attended all department/college awards banquets and social gatherings
   d. I helped chair and judge two sessions of the SRC

(5) I have given a few XRD lab tours when asked and have prepared a 10 min presentation for students grades 5-12.

(6) I have become involved in the broader crystallographic community, both nationally & internationally.
   a. I am an active ACA member.
   b. I attended the 2013 and 2014 annual ACA meetings, presenting a talk at the 2013 meeting
   c. I have been elected to leadership positions in two Scientific Interest Groups (SIGs):
      i. Secretary of the Service Crystallography SIG for 2014-2016
   d. This year at the 2014 ACA meeting, I helped organize the topics of several conference sessions to be in
      the 2015 ACA meeting, and I will be chairing one of the General Interest conference sessions.
   e. I am now listed on the IUCr (International Union of Crystallographers) world directory. The timing of the
      2014 IUCr in August did not allow me to attend, so instead I attended the MIT/Brucker Symposium in
      Boston during February 2014, in which I attended three workshops on structure solution methods given
      by the world’s foremost experts on these topics, making several national & international contacts.
   f. I have become well-connected with numerous personnel at Brucker and PANalytical. I have also
      participated in their respective webinar series as an attendee and have been invited to present a webinar for
      Bruker in October 2014 based on my talk at the 2013 ACA meeting on how to use single crystal XRD
      equipment to perform unique powder XRD experiments.

(7) I have been invited to speak on the vast capabilities of XRD in materials research at the 2015 Pittcon meeting.

(8) I have served as a peer reviewer for several publications involving chemistry and/or crystallography in the
    following journals during the last year:
    a. Inorganic Chemistry (2 manuscripts)
    b. Acta Crystallographica C (4 manuscripts)

(9) I was involved in several existing community programs this year:
    a. Provo Mentoring Program. I was invited to give a 1 hr chemistry magic show on Nov. 1, 2013 to the
       economically underprivileged 6th graders in the program, encouraging them to attend college (and study
       chemistry of course).
    b. Utah Debate Program. In this program, roughly 9,000 4th-9th graders study and debate an
       energy/environmental topic each year. This year the resolutions were related to plastic usage and waste
       treatment. I was invited to be a breakout speaker at the Annual Debate Conference on Nov. 22, 2013,
       giving two 25 minute presentations to a significant fraction of the 500-600 participants to educate them
       about the chemistry of plastic (its formation, properties, and decomposition).
    c. I served as a judge for the Senior Division Chemistry & Biochemistry section of the Central Utah Science
       and Engineering Fair (CUSEF) on March 27, 2014.

(10) I was heavily involved in the STEM out activity held Nov. 9, 2013, helping to organize and orchestrate
    many/most aspects of the event:
    a. I designed the logo, made the announcement fliers, and sent them out to various schools in the area;
    b. I organized all the registrants into groups according to age and interests;
    c. I organized the liquid nitrogen desert/snack;
    d. I recruited student volunteers and arranged for Jen Nielson to do one of the 3 science magic shows;
    e. Together with the YChem president, Will Rankin, I designed the 40 min hands-on chemistry experience
       for the students, running it (the XRD lab tour) myself;
    f. I served on the panel for the question and answer session.
Professional Project
In lieu of a Scholarship Strategist Project

In the Professional Service section of my Faculty Development Plan, I have identified numerous short- and long-term objectives for fulfilling my responsibilities over the X-ray diffraction facilities. One of these is to train students and researchers to collect XRD data and perform analyses themselves. To help me accomplish this long-term objective, I have chosen the following 4 short-term goals to perform as part of my Professional Project:

(1) Create an online X-ray safety training/tutorial along with a quiz and form to be turned in
(2) Generate improved written standard operating procedures (SOPs) for the P-XRD
(3) Restructure the training with the P-XRD instrument and analysis software, potentially including a combination of written information, online tutorials, and hands-on training
(4) Create a series of short online tutorials that students can watch or read on their own to get up to speed on the basics of X-ray diffraction theory

By the end of the FDS Program (Fall 2015 for me), I plan to have accomplished goals 1, 2, and 3 and at minimum have an outline of topics for goal 4. The following are some specific strategies and timelines I plan to implement to help me achieve these goals:

(1) Have “writing office hours.” Set aside 30 minutes a day (4-5 days a week) during Fall 2014 and Winter 2015 to write or create materials for goals 1, 2, and 3 (in that order) without allowing any other activities/interruptions. Once goals 1-3 are complete, use the writing office hour for goal 4.

(2) To help me outline topics and content for goal 4, I plan to read the following three books on crystallography theory during the Fall 2014 and Winter 2015 semesters, reading at least 1 chapter per week on average:
   b. *Crystal Structure Determination*, by Werner Massa
Citizenship Project
“Building Community through Collaboration”

In both the Professional Service and Citizenship sections of my Faculty Development Plan, I have identified numerous short- and long-term goals for enhancing my collaborative efforts with other BYU faculty as well as building my connections with peers in the broader crystallographic community. By the end of the FDS Program (Fall 2015 for me), I plan to have accomplished or be close to completing the following specific projects centered on collaboration. Given in order of priority:

Collaborative Scholarship Activity:
   (1) Give a department seminar (Fall 2014 or early Winter 2015) about ‘The Wonders of XRD’ to introduce everyone in the department to the XRD facilities and to the structural analysis possibilities available through collaboration with me in the XRD facility

Collaborative Teaching Activity:
   (2) Continue to observe colleagues’ teaching during the Fall 2014 and Winter 2015 semesters and invite colleagues to observe and provide feedback on my teaching during my CChem 105 course in Summer 2015

Service Activities:
   (3) Serve in the ACA (American Crystallographic Association):
       a. As the elected secretary of the Service Crystallography Scientific Interest Group (SIG), work with the 2014 and 2015 presidents during the Fall 2014 and Winter 2015 semesters to generate, disseminate, and collect a new national survey of service crystallographers.
       b. Assist with planning the General Interest sessions of the ACA 2015 conference and chair one of them as the elected 2015 president of the General Interest SIG
   (4) Actively participate in and contribute to my committee assignments (Undergraduate Student Advisement, Graduate Student Recruiting, and XRD). In particular, work with the XRD committee to outline a potential fee structure for internal and external usage of the XRD facilities after goal 3a is accomplished.

Activities to build Collegiality:
   (5) Get to know members of my department better. Read the website and vitae of 1 faculty colleague per week over the next year, and try to visit with them in their office that week.
In conjunction with my Professional Project, I am requesting $300 to assist me in enhancing the learning activities for student researchers being trained in the XRD facility in the Department of Chemistry and Biochemistry. Students receive essentially no training in crystallographic theory or practice in the current chemistry curriculum; only senior undergraduate chemistry majors taking the Chem 518 lab class in their last semester at BYU are exposed to any X-ray diffraction at all, and this exposure is minimal (largely hands-off) and qualitative. Thus, in general, the graduate and undergraduate researchers needing to use the XRD facilities have no exposure to X-ray diffraction, and training must start from the ground up.

X-ray diffraction theory is complex and abstract, so I propose to purchase and build items that will enable me to visually illustrate diffraction concepts and bridge the gap between abstract concepts and physical reality. First, I plan to purchase two optical transform kits for the XRD laboratory from the Institute for Chemical Education. These kits contain slides with fine gratings that produce a diffraction pattern when a laser pointer of visible light wavelengths is shone through the slide. Using two of the slides in the Optical Transform Kit (the Discovery and VSEPR slides), I will be able to visually illustrate the reciprocal nature of diffraction and the differences in diffracted intensity caused by shape so that these rather difficult but important concepts can be more readily understood and remembered. The DNA Optical Transform Kit will similarly provide a way for me to visually illustrate how X-ray diffraction was used to solve the structure of DNA – a very interesting and memorable example of how/why X-ray diffraction is useful.

Second, I plan to build models of the different types of symmetry operations in crystallographic group theory including screw axes, glide planes, mirror planes, rotation axes, centers of inversion, and rotoinversion axes. These 3-dimensional operations are some of the most challenging concepts to understand because they are typically taught through two-dimensional illustrations in textbooks, as in Figure 1. Physical, 3-dimensional models would be a much more effective learning tool. In conjunction with BYU’s Precision Machining Laboratory (PML), I will create designs, purchase the necessary materials, and work with the experts in the PML to produce the 3D models. I plan to have these models completed by the end of the FDS program (Fall 2015 for me).

List of specific items to be purchased:
- Optical Transform Kit (including the VSEPR slide) from the Institute for Chemical Education ($25)
  - http://ice.chem.wisc.edu/Catalog/SciKits.html#Anchor-Optical-13405
- DNA Optical Transform Kit from the Institute for Chemical Education ($29)
  - http://ice.chem.wisc.edu/Catalog/SciKits.html#Anchor-Optical-13405
- Materials to build 3D models of crystallographic symmetry operations using the expertise available in the precision machine laboratory

Figure 1. Images of a crystallographic (a) screw axis, (b) glide plane, and (c) rotoinversion obtained at http://em-outreach.ucsd.edu/web-course/Sec-III.C.1-C.5/Sec-III.C.1-C.5.html
SYLLABUS  ·  Chem 105  ·  Sections TBD  ·  ·  Summer 2015

Instructor Information
Name:
Office Phone:
Office Location:
Email:
Office Hours:

Course Description
Welcome to Chemistry 105! This is the first semester in the sequence of introductory chemistry courses for most non-chemistry majors. This course can be used to complete half of the GE Physical Science requirement. The topics in this course will lay the foundation for study in many other science-related fields including the biological sciences, medical and health sciences, geology and earth science, and engineering.

Prerequisites
1) Math 110 (College Algebra), or equivalent, or concurrent registration. Most students who struggle with Chem 105 report that weakness in math skills caused or contributed to their problems. I suggest you have this prerequisite not only completed but current in your skill-set.

2) A strong desire to learn. This is a fast-paced, demanding course. To succeed, you will have to dedicate yourself seriously to your studies EVERY DAY. (Yes, you will need to study daily.)

Learning Objectives
Through this course, you will

1) Gain foundational knowledge
   • be able to use the basic vocabulary and concepts of chemistry
   • understand qualitatively and quantitatively the fundamental chemical laws that govern matter (atoms, elements, compounds, etc.) and energy in the observable universe

2) Apply the knowledge you gain, learning how to think critically and practically
   • analyze situations/problems (critical thinking) and then manipulate equations, proportionalities, and other quantitative descriptors of natural phenomena to solve chemical problems (practical thinking)

3) Integrate knowledge gained in class with other areas of life
   • use your chemistry experience, knowledge, and skills to better understand the world around you and aid you in your own field of study

4) Discover the people in science
   • Learn about famous scientists and realize they are individuals much like yourself

5) Learn how to learn
   • learn how scientists seek truth, construct knowledge, and solve problems, and do so yourself

Required Materials
1) Textbook: Chemistry: An atoms-focused approach, by Gilbert, Kirss, and Foster. This is the required text for both Chem 105 and 106. You will not be required to purchase this book during the first week of class.

2) Access to the online homework system (SmartWork). To enroll in SmartWork, you will need the enrollment key for our class (TBD), a valid email address, and a Registration Code. The registration code comes with new copies of the textbook, or you may purchase a code online at www.wwnorton.com/Smartwork. Once you have a registration code, follow the instructions given on Learning Suite to enroll in SmartWork. To complete these and the other online assignments in this course, you will need daily access to a computer with high-speed internet either at home or through the on-campus computer labs.

3) iClicker transmitter. New or used iClicker transmitters may be purchased from the BYU Bookstore if you do not already own one from another class. Register your transmitter at http://www.iclicker.com/registration/ entering the following four fields: (1) first name, (2) last name, (3) netID (NOT your 9 digit BYU ID number and (4) the number on the back of your iClicker transmitter (note that this number will only contain zeroes, not the capital letter “O”).

4) A basic scientific calculator. You will need a calculator with log and exp functions, but graphing capabilities are not needed. Graphing calculators will not be allowed on exams, so I recommend obtaining a basic scientific calculator at the beginning of the semester and using it throughout the semester. You may rent a scientific calculator from the Testing Center for exams if you choose not to obtain one yourself.
Learning Activities

“Learning is defined as stabilizing, through repeated use, certain appropriate and desirable synapses in the brain.”

– Robert Leamnson

To provide the repetition necessary to effectively learn chemistry and achieve the learning objectives, I have designed the following learning activities (with more detailed descriptions below):

BEFORE CLASS ACTIVITIES:

(1) **Online tutorials (ChemTutorIII and/or ChemCompanion)** (before the M/W/F lectures)

(2) **Reading the textbook** (before the M/W/F lectures)

(3) **SmartWork online homework exercises** (before the T/Th recitations)

DURING CLASS ACTIVITIES

(4) **iClicker quizzes** (during the M/W/F lectures)

(5) **Practice Sheets** (during the T/Th recitations)

AFTER CLASS ACTIVITIES

(6) **Weekly Microexams**

(7) **Integration exercises: writing assignments and exploratory labs**

(8) **Extra credit**

**BEFORE CLASS ACTIVITIES**

(1) **Online Tutorials** – Before M/W/F lectures, you will often be assigned to complete one or more short online tutorials from the following computer-based resources by Dr. John Lamb and Dr. Steve Wood:

ChemTutorIII found at [http://old.chem.byu.edu/faculty/jdl/ChemTutorIII/](http://old.chem.byu.edu/faculty/jdl/ChemTutorIII/)

ChemCompanion found at [http://chempath.byu.edu/chem105/](http://chempath.byu.edu/chem105/)

These tutorials will provide pre-lecture instruction so that you can arrive at lecture already familiar with the basic concepts. My lectures are not designed to be the first time you see/hear the material – if you do not complete these assignments, you will likely feel lost during lectures. I encourage you to take notes during these tutorials.

(2) **Reading the textbook** – Before each M/W/F lecture, you will be assigned to read one or more sections from the textbook. My lectures will follow the textbook, so I encourage you to complete these readings before class; if you choose to read the text after class, you may feel lost during lectures.

(3) **SmartWork online homework exercises** – Before each Tuesday and Thursday recitation, you will be required to complete an online homework exercise through SmartWork. In conjunction with the online tutorials and textbook readings, these assignments are designed to help you learn basic concepts and vocabulary so you can apply them to more difficult problems given in the Practice Sheets and Microexams.

**DURING CLASS ACTIVITIES**

(4) **iClicker quizzes** – During each M/W/F lecture, there will be roughly 3-6 short quizzes dispersed throughout the lecture. You will be expected to answer these quizzes through the iClicker electronic response system using your own iClicker (electronic transmitter) that has been registered to your name & BYU netID. These quizzes are intended to be primarily formative, helping you firm basic concepts/vocabulary in your mind and giving me immediate feedback on how well you understand the concepts we are covering so I can spend more time on those concepts that are less understood. Half of the points are awarded simply for participating, the other half for the correct answer. These quizzes also encourage your punctual and regular attendance.

Bring the transmitter with you to every lecture, including the first day. This is the only way to earn the quiz points.

(5) **Practice Sheets** – When you arrive at each T/Th recitation you will be given a set of roughly 5 challenging/multistep problems to do during the recitation. You will work these problems in groups; at the beginning of the semester, your TA will split your class into 5 groups that you will work in for the rest of the semester. For the first 25 min of class, each group will start working on a different problem initially. When that problem is finished, you will work through the other 4. During the second 25 min of class, each group will work their problem step-by-step on the board in front of the class (5 min time limit), leading the class in working together to solve the problem. Your TA will have already worked through the problems and so can help the various groups as needed and guide the class discussions.

BE SURE TO COMPLETE ANY UNFINISHED PROBLEMS LATER ON AT HOME. You will need to understand how to do all the problems to do well on the exam questions, many of which will be based on these very practice sheet problems. A detailed key to each Practice Sheet will be posted on Learning Suite at midnight the day of the recitation.
AFTER CLASS ACTIVITIES

(6) **Microexams** – At the end of each week, you will complete a short online exam to test your mastery of the concepts and problem-solving skills learned that week. The microexams will be designed to take approximately 60 minutes to complete and are closed-book while you are taking it—the only materials you should have on hand are scratch paper, a pencil, your calculator, and a copy of the Chem 105/106 equation sheet and periodic table. This best simulates the exam experience in the Testing Center. You should be able to use your initial performance on the exam as a gauge of how well you learned the material that week, but to encourage you to shore up any weak points, you may retake each microexam as many times as you wish while it is still open. A small percentage (2%, or 0.4 points) will be deducted from your score for each attempt to motivate you to take each attempt seriously. Between attempts, you may look at any written or computer materials but you may not consult with any other student(s); just as the exams are individual experiences, this needs to be an individual learning experience. Your highest score will be your final score. A non-credit version of the microexams will be available for review once the deadline has passed to aid you in studying for the exams.

(7) **Integrative exercises** – You will be given 5 ‘integrative exercises’ during the semester to help you integrate the knowledge you gain in class with other areas of your life and aid you in your own field of study. Specifically, you will have one writing assignment at the beginning of the semester, a follow-up writing assignment at the end of the semester, and 3 mandatory Exploratory Lab experiences throughout the semester.

The **Exploratory Lab** is intended to provide you with the opportunity to experience chemistry hands-on so you can connect the abstract concepts we learn in class with physical reality and everyday life. As the lab manual states, “the exploratory experiments are intended to be both fun and instructive, but to be successful as a learning aid they must be approached with the right attitude. If you approach the exploratory lab with a good-humored, thoughtful, and receptive attitude, we promise you will experience some of the fun, wonder, and excitement of doing science.”

(8) **Extra Credit** – For students who wish to enrich their learning experience, you will have the opportunity to do one exploratory lab or virtual lab experiment each week for extra credit. This will be the only way to earn extra credit.

The extra credit **Exploratory Lab** worksheets can be downloaded and printed from Learning Suite. Each lab will be open during one particular week in the semester, and you will need to turn in the corresponding completed worksheet to your TA by the following Tuesday recitation, no exceptions.

**Virtual Chemistry Lab (VCL)** is a sophisticated, realistic computer simulation of a chemistry lab prepared by BYU Professor Brian Woodfield and colleagues. **Boltzmann 3D** is a similarly sophisticated computer program for simulating the motion of atoms/molecules prepared by BYU Professor Randy Shirts and colleagues. You may purchase a VCL CD from the BYU Bookstore, or you may access it and Boltzmann 3D free of charge in the Chemistry Department computer lab in N175 (the Nichols Bldg attached to the north end of the long hallway of labs in the BNSN). To get login rights to the computers in that room, you have to be officially registered in a chemistry class (which you are), go to the kiosk in N175, swipe your BYU ID card, and follow the prompts. The room is open from about 7 am to about 10 pm, including most Saturdays. To do the VCL and Boltzmann assignments, download the modified instructions and report sheets posted on Learning Suite, and turn in the completed worksheets to your TA by the following Tuesday recitation.

**Exams**

Three full-length exams will be administered during the semester. Each exam will be comprehensive, meaning they can draw on any material discussed in class up to that point. Problems on the exams will be a combination of multiple choice, true/false, and open response. Exams will test not only your understanding of the concepts, but also your ability to solve problems that aren’t exactly like ones you have already seen and your ability to use your chemistry knowledge to understand and explain the world around you.

Each exam will be administered in the Testing Center over a 2-3 day period. The exams will have no time limit, but they should take less than 2 hours if you are well prepared. Look carefully at the course calendar and Testing Center hours and plan ahead so that you do not miss any exams; there will be no make-up exams. If there is a serious and unavoidable reason beyond your control that will prevent you from taking an exam during the scheduled time (e.g., serious illness or death), see me, Dr. Smith, before the exam. If an emergency arises during the exam period, both send me an email and call my office phone (the number is on page 1 of this Syllabus)—if I’m not there, leave a phone message. If you miss a macro-exam without contacting me, you will receive a score of 0.

**Final Exam**

The final exam for the course will be comprehensive and is designed to take approximately 3 hours, though there will be no time limit. The exam will be administered through the Testing Center and must be taken during finals week—no exceptions. **If you do not take the final, you will receive an “E” in the class.**
Assessment (Grading Policies)
Your grade percentage will be based on the following weights:

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>iClicker Quizzes, 35 highest of 42</td>
<td>7.5%</td>
</tr>
<tr>
<td>Practice Sheets, 15 highest of 27</td>
<td>7.5%</td>
</tr>
<tr>
<td>SmartWork assignments, 20 highest of 27</td>
<td>7.5%</td>
</tr>
<tr>
<td>Microexams, 10 highest of 13</td>
<td>7.5%</td>
</tr>
<tr>
<td>Integration exercises</td>
<td>5.0%</td>
</tr>
<tr>
<td>Exams, (3)</td>
<td>45.0%</td>
</tr>
<tr>
<td>Final exam</td>
<td>20.0%</td>
</tr>
</tbody>
</table>

Total possible.................................................. 100.0%

Your grade percentage will be used to determine your letter grade in the course based on a scale that will be adjusted throughout the semester according to the performance of the class.

Assignment-Specific Grading Policies:

1) **iClicker Quizzes** – The iClicker questions from each day of class will count as 1 iClicker quiz, and each quiz will have equal point value in your final grade regardless of the number of questions that day. Only your 35 highest quiz scores (of the 42 possible) will be counted toward your grade. You must attend class and complete the quizzes using your transmitter to receive these points; there is no other way. Each iClicker question will be worth 2 points; 1 point will be awarded for answering the question (i.e. for being present at and participating in class), and 1 point will be awarded for selecting the correct answer. One of the iClicker questions each day might be to answer whether or not you completed the Before Class reading and/or online tutorial assignments...

2) **Practice Sheets** – Each practice sheet will be worth 4 points: 1 point for attending the entire recitation during which it is worked, 1 point for participating with your group to solve the problems, 1 point for participating in working/explaining your group’s assigned problem at the board with the rest of your group, and 1 point for the board work being correct. Your TA will assign these points for each individual after each recitation. There will be one practice sheet score per recitation (27 total). Your highest 15 scores will count toward your grade. You must be present at and working during the recitation to receive points – there is no other way.

3) **SmartWork assignments** – As with iClicker quizzes, each SmartWork assignment will have equal point value regardless of the number of problems in the assignment. Your highest 20 scores (of 27 possible) will count toward your grade.

4) **Microexams** – Each microexam will be worth 20 points. Your highest 10 microexam scores (from the 13 possible) will count toward your grade. You may retake each microexam as many times as you wish during the week it is open, but a small percentage (2%, or 0.4 points) will be deducted from your score for each attempt to motivate you to take each attempt seriously.

5) **Integrative exercises** – The two writing assignments and 3 exploratory labs will each be worth 1% of your grade for a total of 5%. The rubric used to grade these assignments will be posted on Learning Suite.

6) **Exams** – Each midterm exam will be worth 15% of your grade for a total of 45% for the 3 midterm exams. The final exam will be worth 20% of your grade. **All exams are comprehensive**, meaning they can cover any material discussed in class up to that point.

**Drop Policy** In a class as large as ours, I have had to be creative in addressing the many types of problems students may have in submitting assignments on time. I have thus provided a generous “drop” policy to take care of such problems; as shown above, your 7 lowest iClicker quizzes, 7 lowest SmartWork assignments, 12 lowest Practice Sheet scores, and 3 lowest Microexam scores will be dropped. This includes assignments that were missed for any reason including technical difficulties, sickness, or travel (including BYU-approved travel). There will be no make-up assignments, so you should not waste “drops” for frivolous reasons—drops are your only recourse in case of a real emergency. You may keep track of legitimate problems beyond your control which have prevented you from completing or submitting assignments on time, and if such problems have impacted more than the allotted drops, then you may contact me to discuss an appropriate remedy. But wait to approach me until you have used up your drops.

**Checking your Scores** Your scores will be posted regularly on Learning Suite. It is important that you check your scores periodically for accuracy and so you are more aware of how you are doing. **Report any problems to your TA. All problems with recording of scores must be resolved by the last day of lecture.**
Suggestions on Study Habits

For many of you, this is your first year at university. WELCOME! You have embarked on a new and radically different educational experience than you have had previously. “Higher” education means that the learning expectations go beyond knowledge and comprehension, which are basic; here you are expected to perform more sophisticated cognitive processes including critical analysis, synthesis, and integrative thinking. You will be expected to learn outside class and prepare yourself to face problems on exams which are not identical to those you have seen before. In a university setting, the responsibility for your learning rests largely on your shoulders rather than on the instructor’s; you are expected to take full personal responsibility for your own progress in the class. Here is a rule of thumb for the amount of time you’ll need to spend per class: suggested by the

“Study two hours per credit hour for a lighter class, three hours per credit hour for an average class, and four hours per credit hour for a difficult class.”

BYU Counseling Center

For most of you, this will be a difficult class and will thus likely require 3-4 hours of study per credit hour, or 12-16 hours/week of work outside of class to do well. I have designed the course learning activities to take roughly this amount of time. For some it may take less, for others it might take more. But more important than the quantity of time spent is the quality of time spent; if you understand a concept, review it briefly for repetition then move on to the problems and concepts you don’t understand and spend more time and repetition with those. We all like doing things we are good at, but you don’t grow until you push yourself to do or learn new things that you may not be as good at yet.

It will require self-discipline to keep up with your assignments and meet posted deadlines. I strongly encourage you to use some kind of personal planner, either paper or electronic, to help you remember deadlines—I will not always remind you when the deadlines posted in the class calendar are coming. In a sense, part of your grade reflects your ability to act in a responsible manner to perform work on time. Exercising discipline in this way will help you develop a level of professionalism that will serve you well throughout your life.

Student Resources

This is a large class, and it is easy to get lost. We provide a variety of resources to ensure that you don’t, and that you can get help when you need it. Here are some places that you can go for help.

Dr. Smith – My office hours are listed at the beginning of this syllabus, and I encourage you to come and see me during those hours. I will be happy to help you with any problems you have in understanding the course material. If you can’t make my office hours, feel free to email me to make an appointment. Do not hesitate to come and see me—I enjoy visiting with my students.

TA’s – Your TA is a student who has excelled in chemistry courses. You will be meeting twice a week with your TA during recitation, and in addition he/she will also hold office hours that will be posted on Learning Suite.

Tutorial Lab – The Chemistry Department provides a free tutoring lab in W152 BNSN for all general chemistry students. All of the TAs for Chemistry 105 and 106 hold office hours in that tutorial lab. If you are unable to meet with your TA when he/she is there, you can go to the lab and get help from another TA. The lab is usually open during the regular school day—lab hours are posted on the door and on Learning Suite.

Learning Suite – On Learning Suite you will be able to find copies of course documents including the syllabus, calendar, microexams, problem keys, etc. You can also go to the site to check your scores. You can only access this site if you are officially registered in the class. The materials on this site are copyrighted and it is illegal to copy them to other sites or use them in any way outside the scope of your role as a student in this class.

Fellow students – I encourage you to work together with classmates in discussing class material, doing practice problems and preparing for exams. You help yourself understand the material better by helping another student understand it. Just be sure that you don’t fall into the trap of riding someone else’s coat tails. Ultimately, you are responsible for understanding the material, and you will be on your own when you take the exams. It would be a serious violation of the honor code to work together on microexams or communicate about the content of exams while they are still available in the Testing Center.

Accessibility Center – If you find yourself struggling in the class or in need of special help, visit the Accessibility Center in the WSC. There you will find counselors who can help you—don’t put off doing this until it is too late!

Student Disability

Brigham Young University is committed to providing a working and learning atmosphere that reasonably accommodates qualified persons with disabilities. If you have any disability which may impair your ability to complete this course successfully, please contact the Services for Students with Disabilities Office (422-2767). Reasonable academic accommodations are reviewed for all students who have qualified, documented disabilities. Services are coordinated with the student and instructor by the SSD Office. If you need assistance or if you feel you have been unlawfully discriminated against on the basis of disability, you may seek resolution through established grievance policy and procedures by contacting the Equal Employment Office at 422-5895, D-285 ASB.
Drops & Incompletes ("I"s)
Be aware that the University has strict policies on completing courses for which you have registered. Don't just give up at some point and expect that somehow the grade will turn out okay—it won't. There is a drop deadline without "W" (withdrawal) on your transcript and another with "W". Incomplete, or "I" grades, are given only rarely under extreme circumstances beyond your control, after most of the semester has passed, and never if the student is doing poorly or failing. Please see me as soon as you think you might have a problem completing the course.

Honor Code
In keeping with the principles of the BYU Honor Code, students are expected to be honest in all of their academic work. Academic honesty means, most fundamentally, that any work you present as your own must in fact be your own work and not that of another. Violations of this principle may result in a failing grade in the course and additional disciplinary action by the university. Students are also expected to adhere to the Dress and Grooming Standards. Adherence demonstrates respect for yourself and others and ensures an effective learning and working environment. It is the university's expectation, and my own expectation in class, that each student will abide by all Honor Code standards. Please call the Honor Code Office at 422-2847 if you have questions about those standards.

Academic Honesty
The first injunction of the BYU Honor Code is the call to be honest. Students come to the university not only to improve their minds, gain knowledge, and develop skills that will assist them in their life's work, but also to build character. President David O. McKay taught that "character is the highest aim of education" (The Aims of a BYU Education, p. 6). It is the purpose of the BYU Academic Honesty Policy to assist in fulfilling that aim. BYU students should seek to be totally honest in their dealings with others. They should complete their own work and be evaluated based upon that work. They should avoid academic dishonesty and misconduct in all its forms, including but not limited to plagiarism, fabrication or falsification, cheating, and other academic misconduct.

Plagiarism
Writing submitted for credit at BYU must consist of the student's own ideas presented in sentences and paragraphs of his or her own construction. The work of other writers or speakers may be included when appropriate (as in a research paper or book review), but such material must support the student's own work (not substitute for it) and must be clearly identified by appropriate introduction and punctuation and by footnoting or other standard referencing. The substitution of another person's work for the student's own or the inclusion of another person's work without adequate acknowledgment (whether done intentionally or not) is known as plagiarism. It is a violation of academic, ethical, and legal standards and can result in a failing grade not only for the paper but also for the course in which the paper is written. In extreme cases, it can justify expulsion from the University. Because of the seriousness of the possible consequences, students who wonder if their papers are within these guidelines should visit the Writing Lab or consult a faculty member who specializes in the teaching of writing or who specializes in the subject discussed in the paper. Useful books to consult on the topic include the current Harcourt Brace College Handbook, the MLA Handbook, and James D. Lester's Writing Research Papers.

Copyright
All materials provided to students in this class, whether electronically or on paper, are copyrighted and it is illegal to copy them to other sites or use them in any way outside the scope of your role as a student in this class.

Sexual Harassment
Title IX of the Education Amendments of 1972 prohibits sex discrimination against any participant in an educational program or activity that receives federal funds. The act is intended to eliminate sex discrimination in education and pertains to admissions, academic and athletic programs, and university-sponsored activities. Title IX also prohibits sexual harassment of students by university employees, other students, and visitors to campus. If you encounter sexual harassment or gender-based discrimination, please talk to your professor; contact the Equal Employment Office at 801-422-5895 or 1-888-238-1062 (24-hours), or http://www.ethicspoint.com; or contact the Honor Code Office at 801-422-2847.

Respectful Environment
"Sadly, from time to time, we do hear reports of those who are at best insensitive and at worst insulting in their comments to and about others... We hear derogatory and sometimes even defamatory comments about those with different political, athletic, or ethnic views or experiences. Such behavior is completely out of place at BYU, and I enlist the aid of all to monitor carefully and, if necessary, correct any such that might occur here, however inadvertent or unintentional. I worry particularly about demeaning comments made about the career or major choices of women or men either directly or about members of the BYU community generally. We must remember that personal agency is a fundamental principle and that none of us has the right or option to criticize the lawful choices of another," President Cecil O. Samuelson, Annual University Conference, August 24, 2010. "Occasionally, we ... hear reports that our female faculty feel disrespected, especially by students, for choosing to work at BYU, even though each one has been approved by the BYU Board of Trustees [which includes a member of the First Presidency]. Brothers and sisters, these things ought not to be. Not here. Not at a university that shares a constitution with the School of the Prophets." Vice President John S. Tanner, Annual University Conference, August 24, 2010.
Teaching Philosophy

I have tried to use an integrated approach to designing this course. This means I have thought simultaneously about what I want you to take away from this course long-term (learning objectives), what assessments might be used to measure whether you’ve met these learning objectives, and what learning activities will help you get there. I then planned and revised the course schedule iteratively until I felt that all three were aligned. In addition, I tried to incorporate a variety of learning activities in order to accommodate the variety of learning styles each of us finds most effective. Here I explain how the course I have planned achieves these ends (or so I hope).

The first objective in this class is to build foundational knowledge. It has been said that there is more new vocabulary in General Chemistry than in a first-year Spanish class, and though I have not rigorously proven this, my instinct is that it is true. I intend for you to gain this foundational knowledge, becoming familiar with the basic terminology and concepts of chemistry, primarily through your Before Class reading and online assignments. Lectures will continue to develop your understanding of the basic concepts, but lectures should not be your first or primary exposure to them. Assuming you take notes both during lectures and during the Before Class assignments as I suggest, these activities will incorporate 4 different learning styles so that the needs of those who favor visual images (online assignments & lectures), audible explanations (online assignments & lectures), methodical conceptual outlines (textbook readings), and kinesthetics (writing notes) will all be met.

The second objective is for you to learn how to apply the knowledge you gain. In lectures MWF, I will work example problems and show you how to begin applying chemistry knowledge. You will then practice applying your knowledge through the online SmartWork assignments, cementing the basic concepts and vocabulary in your mind. Then in the Practice Sheets in TTh recitations as well as the weekly Microexams, you will apply your knowledge to more difficult problems, further developing your critical thinking and problem solving skills. Recitations will also incorporate the element of human interaction; even though learning is ultimately an individual experience, studies have shown (for both extroverts and introverts) that sharing the learning process with others greatly enhances it. After all, I believe you don’t truly understand something until you can explain it effectively to another person, and by attempting to verbalize your ideas, you quickly see where your understanding is lacking. Thus, recitations will incorporate a social aspect to learning as you strive to meet learning objective #2, applying chemistry knowledge.

The third objective is to integrate your chemistry knowledge with real life – to use the microscopic concepts you learn in the classroom to explain the macroscopic world around you and aid you in your particular field of study. To help you begin making real world connections, it is my goal for every lecture to point out at least one example of how the abstract concepts we are learning are actually manifested in and impact things in the physical world. The abstract concepts in class will further be connected to physical reality in the 3 exploratory labs you will do as part of the integrative exercises (as well as the extra credit exploratory labs, if you choose to complete those). The writing assignments will help you realize how chemistry will help you in your particular discipline so that you will be better able to integrate what you learn in Chem 105 with what you will focus on in the future.

The fourth objective in this class is to introduce you to scientists. In today’s society, we grow up being presented with many advanced scientific “truths” (i.e. the world is round, stars are giant balls of hot gas, etc.) without really being taught how scientists came to know these things. This makes science seem enigmatic and mysterious. But really, scientific discoveries were the results of careful, methodical thought and work by ordinary people just like you! In many lectures, I will give background stories and details about the scientists involved in important discoveries/advances so that, as #4 says, you can discover and learn about the people involved in science and realize that they are flawed individuals just like yourself. And if they can do science, so can you!

The final objective in this class is for you to learn how to learn like a scientist. One of the ways I hope to achieve this is by introducing you to the people in science; by sharing their stories and thought processes as well as my own, you will hopefully be able to understand the logical, methodical, and analytical way in which chemists think and deduce knowledge from the world around them. I will try to model these logical thought processes during class as we solve problems. Then, through your own experience with the various homework assignments and exploratory lab experiments, I hope you will learn to use this ‘scientific method’ (or logical way of seeking truth, constructing knowledge, and solving problems) so that you can apply it to problems throughout your life outside of a chemistry classroom.