Chemistry MS

Students Should Be Able to Safely and Effectively Carry Out a Research Project

Goal Description:

Aspiring chemists who pursue an MS degree must have the ability to safely and effectively carry out a research project. This skill is essential as it enables them to contribute to the scientific community by conducting groundbreaking research and developing new technologies. Being able to carry out research projects safely is crucial, as it ensures that the results obtained are accurate and reliable. Additionally, effective research skills are necessary to complete projects within the allocated time frame and budget. These qualities are highly valued in various careers in chemistry, including research and development, pharmaceuticals, and materials science. Therefore, mastering research skills is essential for those pursuing an MS degree in chemistry and wishing to excel in their careers.

Students should be able to formulate a clear problem statement they wish to explore and use the scientific method to find answers to that problem. In the process, students should generate new knowledge or integrate existing knowledge in new ways. They should be able to accomplish this in a safe way by being aware of hazards and reducing risk while performing laboratory experiments.

Providing Department: Chemistry MS

Progress: Completed

RELATED ITEMS/ELEMENTS

RELATED ITEM LEVEL 1

Plan, Perform, and Analyze Experiments

Learning Objective Description:

These are three critical components to research in the chemical sciences. Students should be proficient in all three areas.

RELATED ITEM LEVEL 2

Students Write an Acceptable Thesis Prospectus for Their Research

Indicator Description:

A thesis prospectus is a formal proposal for a research project and should include the following:

- Explanation and purpose of the project and expected outcomes of the research.
- Outline of the proposed procedures and methods of investigation.
- Relationship of the study to relevant research and findings by scholars in the general area of concentration.
- Description of required materials and/or facilities available for the successful completion of the research.

Criterion Description:

A submitted and approved Thesis Prospectus Approval Form will serve to indicate whether a student's Thesis Prospectus has been approved. The Thesis Prospectus must be approved by the student's Advisory Committee, Department Chair, and COSET Dean. A prospectus is required of all students in a thesis track of the MS Chemistry, and 100% of students should pass the step by the end of their fourth fall/spring semester in the program (since many students graduate in the subsequent summer).

Findings Description:

Although 100% of students did write a prospectus that passed committee, Chair, and COSET checks, so the criterion was met, there is an issue that needs action. A student rarely does it early enough for proper review before the COSET deadline, so the committee and Chair end up scrambling to read and

evaluate the document (and do revision cycles with the student) before the deadline. This lowers the quality of the finished product and teaches students the wrong lesson. We should take action to require the students to complete the task earlier.

RELATED ITEM LEVEL 3

Action - Acceptable Thesis Prospectus

Action Description:

The Chair (Dr. Haines) and Graduate Coordinator (Dr. Gross) should discuss the problem of students not getting their Prospectus done early enough with the faculty, and a plan to change the behavior established. This is necessary to ensure the Prospectus written and approved has high quality and the learning experience of writing it is fully effective. That plan will be created in Fall 2023 adn implemented in Spring 2024.

RELATED ITEM LEVEL 2

Students should successfully complete the research course (CHEM6398)

Indicator Description:

This measure indicates that the student has made sufficient research progress for completion of their thesis. A grade for the research course is typically assigned once the research component of the thesis is complete.

Criterion Description:

Success will be indicated by all graduate students receiving a passing grade in the Graduate Research in Chemistry (CHEM6398) course. This grade is typically an A and assigned once the research project has been completed.

Findings Description:

Both students who gradauted had been evaluated as successfully completing their MS thesis project research (and given an A in CHEM 6398) as well as two students who are expected to defend theses and graduate in the upcoming students. The criterion was met.

RELATED ITEM LEVEL 3

Action - Completion of Research Course

Action Description:

The criterion was met, no action is needed.

RELATED ITEM LEVEL 1

Students Should Be Able to Carry Out Research Safely

Learning Objective Description:

Students should be able to recognize hazards, assess the risks of the hazards, minimize the risks of the hazards, and prepare for emergencies from uncontrolled hazards.

RELATED ITEM LEVEL 2

Students should successfully complete the research course (CHEM6398)

Indicator Description:

This measure indicates that the student has made sufficient research progress for completion of their thesis. A grade for the research course is typically assigned once the research component of the thesis is complete.

Criterion Description:

Success will be indicated by all graduate students receiving a passing grade in the Graduate Research in Chemistry (CHEM6398) course. This grade is typically an A and assigned once the research project has been completed.

Findings Description:

Both students who gradauted had been evaluated as successfully completing their MS thesis project research (and given an A in CHEM 6398) as well as two students who are expected to defend theses and graduate in the upcoming students. The criterion was met.

RELATED ITEM LEVEL 3

Action - Completion of Research Course

Action Description:

The criterion was met, no action is needed.

Students Should Develop Oral and Written Communication Skills

Goal Description:

Effective communication skills are essential for success in any field, but they are especially crucial for professionals in careers requiring an MS in Chemistry. Both oral and written communication skills are necessary for conveying complex scientific information to colleagues, clients, and other stakeholders. Professionals with strong communication skills can explain complex chemical concepts in a way that is easy to understand, which is critical for collaborating with interdisciplinary teams and presenting findings to non-experts. Moreover, clear and concise written communication is essential for publishing research papers, securing funding, and sharing findings with the wider scientific community. In short, communication skills are essential for professionals in chemistry-related fields, and those with an MS in Chemistry must work hard to develop and hone these skills to be successful in their careers.

Students should have opportunities to develop those skills.

Providing Department: Chemistry MS

Progress: Completed

RELATED ITEMS/ELEMENTS

RELATED ITEM LEVEL 1

Students Demonstrate Presentation Skills

Learning Objective Description:

Students completing CHEM 5100 will, at least once during their tenure as graduate students, demonstrate the ability to make a quality research presentation. Students will also present their thesis research during their thesis defense.

RELATED ITEM LEVEL 2

Acceptable Student Seminar Peer-Reviewed Presentation

Indicator Description:

During their tenure as graduate students, all students will present at least one departmental seminar. The faculty, with the assistance of the peer-review evaluation rubric, will determine the presentation's acceptability.

Criterion Description:

All graduate students in chemistry are required to take CHEM 5100 at least once during their tenure as graduate students. To pass CHEM 5100, students are required to receive an acceptable peer-rating on a required research presentation. It is expected that student feedback after the lightning talks will be incorporated and result in the improvement in greater than 90% of the full-length presentations.

Attached Files

Spring_2022_20821.pdf

Findings Description:

In Fall 2022, 11 of 12 students, and in Spring 2023, 4 of 6 students gave an acceptable presentation. The criterion was not met. This was a change from previous semesters, wher typically all students meet the criterion.

RELATED ITEM LEVEL 3

Action - Acceptable Student Seminar Peer-Reviewed Presentation

Action Description:

We have developed a new course to help students succeed in graduate school. This should help students who come in under-prepared to be successful in their coursework. The first offering of this course is Fall 2023. We will re-evaluate progress next cycle.

RELATED ITEM LEVEL 2

Graduating MS Chemistry Students can Present (Defend) Their MS Thesis Work

Indicator Description:

The thesis defense involves an open (public) presentation of the student's research (about 1 hour with questions). After it ends, everyone except the student, the committee, and interested faculty is asked to leave. The committee will then carry out the closed portion of the thesis defense and simultaneously the oral comprehensive examination.

Students typically pass both the thesis defense and oral comprehensive examination simultaneously. Although, because they are separate entities and they both have pass/fail options, it is possible to pass one and not the other.

Criterion Description:

During their final semester, all students will present and defend their research at an acceptable level (to the approval of their committee).

Findings Description:

Two students graduated with the MS in Chemistry in the '22-23 academic year. Both passed their thesis defenses on the first try, so the criterion is met. However, one did have a very high number of corrections to the thesis itself and, along with a needed retake of the comprehensive exam, took an extra semester to graduate. Though the criterion was technically met, given the complications for one of the students some action for improving theses and defense of theses is warranted.

RELATED ITEM LEVEL 3

Action - Graduating MS Chem Defending Thesis

Action Description:

Although the criterion was met, the fact that 50% of students struggled with the content of the thesis itself delaying graduation means more training is warranted. In Fall 2024 we are offering a new graduate course to help graduate students be more successful in graduate school, this course should incorporate some discussion of how a thesis is written and defended to help provide more context.

RELATED ITEM LEVEL 1

Students Demonstrate Skills in Publishing Research

Learning Objective Description:

Students pursuing a thesis-based MS degree will disseminate their results by writing and publishing a thesis based on their research.

RELATED ITEM LEVEL 2

Graduating MS Chemistry Students Write a Thesis

Indicator Description:

A thesis research project will culminate in the production of a written thesis. The thesis should be written in the scientific writing format and follow the style guidelines set forth by the American Chemical Society. The thesis will be evaluated by the student's advisory committee, the COSET Dean, and the graduate school.

Criterion Description:

All student will work with their research advisors to write an acceptable thesis.

Findings Description:

Of the two students who graduated in '22-23, both wrote a thesis acceptable at all levels. However, one of the two needed extended time to make extensive thesis corrections. Therefore, some action improving the quality of theses is warranted.

RELATED ITEM LEVEL 3

Action - Writing a Thesis

Action Description:

Because one of two students needed extra time to complete extensive revisions to their thesis after it was defended, action to improve thesis writing is warranted. A new course will be offered in Fall 2023, with content focusing on how to be a successful graduate student. Thesis writing will be one of the topics of that course.

RELATED ITEM LEVEL 1

Students Present and Publish the Results of Their Research

Performance Objective Description:

The effective communication of science is a skill students need to develop. Publication of their work in national and international journals and presentation at professional meetings will allow students to gain or improve these skills. These activities will also help to raise the visibility of the department.

RELATED ITEM LEVEL 2

Research Publications by Graduate Students

KPI Description:

The number of research publications with graduate student authors or co-authors will indicate departmental success in preparing students to report research findings in written form. We expect that all graduate students who complete their M.S. degrees will have one or more publications in print, accepted, or near submission.

Target Description:

100% of graduate students who complete their M.S. degrees will have one or more publications in print, accepted, or near submission.

Results Description:

Of the two students graduating with an MS in Chemistry, one had one peer-reviewed co-authored manuscript, but the other did not. Both had numerous conference abstracts.

One issue is a lag in time for articles to be submitted, accepted, and appear in print. In the future, this target may need to be revised to measure manuscripts that will eventually appear in print but have not yet at the time of assessment.

RELATED ITEM LEVEL 3

Research Publications by Students

Action Description:

The target was not met, but as noted the issue may more be about the assessment timeline than a deficiency in productivity and training. Therefore we will discuss a more appropriate assessment for next year.

RELATED ITEM LEVEL 2

Student Presentations at Professional Meetings

KPI Description:

The number of presentations by graduate students at professional meetings will indicate the success of the department in preparing students to orally present their research results. We expect that every graduate student who completes their M.S. degree will have will have made one or more presentation at a regional or national professional meeting (typically American Chemical Society (ACS) Meetings, but some groups attend Society of Toxicology and other related or specialized meetings).

Target Description:

100% of MS degree graduates will have at least one conference presentation at a regional or national meeting at the time of graduation.

Results Description:

Two students graduated with an MS in Chemistry, both in May 2023. One student had coauthored 4 presentations at American Chemical Society (ACS) meetings, and the other had 2 (list of abstracts attached). The target was exceeded by a significant margin.

Attached Files

Presentations by graduating Chemistry graduate students 22-23.docx

RELATED ITEM LEVEL 3

Student Presentations at Professional Meetings

Action Description:

The target was exceeded, no action needed.

Students Should Have Well-Rounded Graduate-Level Knowledge in Most Major Subfields of Chemistry

Goal Description:

As a student pursuing an MS Chemistry program, it is crucial to have knowledge and skills from at least four major areas of chemistry. This is because chemistry is a vast field, and a chemist needs to have a broad understanding of different branches of the subject. By taking courses from diverse areas such as organic chemistry, analytical chemistry, physical chemistry, and inorganic chemistry, they will be able to develop an in-depth understanding of the subject matter. Furthermore, they will be equipped with the necessary skills to conduct research, analyze data, and make sound scientific conclusions. Having a comprehensive understanding of the different areas of chemistry will also prepare them for a broad range of career opportunities, including those in academia, industry, and research. Therefore, it is essential to take courses from at least four major areas of chemistry to succeed in the MS Chemistry program and in their future career.

The program will address the discipline-specific knowledge dictated by professional societies and/or professionals in the workforce. Students are required to take courses in at least four major areas of chemistry to complete their degree (typically over the course of two years). Each year four lectures in three to four areas are offered. This year's courses were in Organic Chemistry, Analytical Chemistry, Inorganic Chemistry, and Biochemistry.

A description of the degree plan and course requirements can be found at http://catalog.shsu.edu/graduate-and-professional/college-departments/science-and-engineering-technology/chemistry/chemistry-ms/#curriculumtext.

Providing Department: Chemistry MS

Progress: Completed

RELATED ITEMS/ELEMENTS

RELATED ITEM LEVEL 1

Students Develop Sufficient Knowledge of Chemistry at the Graduate Level and Can Apply It

Learning Objective Description:

Students should not only retain the knowledge from their coursework but also be able to apply it to their chosen research field.

RELATED ITEM LEVEL 2

Students Pass the Comprehensive Oral Exam

Indicator Description:

As part of the degree requirements, students are required to pass a an oral comprehensive exam over material from their coursework. The exam will involve asking students questions related to their thesis and testing their general knowledge of chemistry.

Criterion Description:

All students attempting the comprehensive exam will pass by demonstrating sufficient knowledge in chemistry to their advisory committee.

Findings Description:

All students graduated that attempted the oral comprehensive examination this year, a total of 2 students. However, one student failed on the first attempt and had to be tested a second time.

Technically the criterion is met, both passed an oral comprehensive exam. The need for two attempts after a recent student needed three attempts suggested action is warranted to improve student performance on these exams.

RELATED ITEM LEVEL 3

Action - Passing of Comprehensive Oral Exam

Action Description:

Because one of two students needed multiple attempts to pass, action to improve student performance is warranted. A new course will be offered in Fall 2023 that incoming graduate students will take. The course is designed to support student success and help assess their prerequisite knowledge. As part of this course, the goal of the oral comprehensive exam and strategies to prepare for it will be discussed.

RELATED ITEM LEVEL 1

Students Should Be Able to Demonstrate Graduate-Level Chemistry Knowledge in the Subfield Biochemistry

Learning Objective Description:

Students that take the course CHEM 5372 Advanced Biochemistry should be able to demonstrate graduate level knowledge of biochemistry including enzyme kinetic data analysis, use of primary literature, and general understanding in the field.

RELATED ITEM LEVEL 2

Students Can Analyze Enzyme Kinetics Experiments

Indicator Description:

Given enzyme kinetic data to analyze, students should be able to use Excel to apply the Michaelis-Menten equation to determine the substrate binding constant Km, the catalytic ('turnover') rate constant kcat, and inhibition constants (Kis and Kii). They should also be able to determine the type of inhibition.

They will be given a dataset as part of a take-home exam that they will have one week to complete.

Criterion Description:

90% of students will correctly determine Km, Kcat, Kis, and Kii as well as the type of inhibition observed.

Findings Description:

It was discovered early during CHEM 5372 in Spring 2023 that students' background chemistry was lacking, and the course had to be restructured as it proceeded to fill in gaps in prerequisite knowledge. One unfortunate side effect was that students did not then do detailed kinetic analysis (although they certainly learned kinetic derivations and simple applications of the equations).

Next time the course is offered, this assessment should be given.

RELATED ITEM LEVEL 3

Action - Analyze Enzyme Kinetics Experiments
Action Description:
The assessment itself failed to take place. The next time the course is offered, Dr. Haines will attempt to assess this again. The scheduling varies, but that will be in approximately two years.

RELATED ITEM LEVEL 2

Students Can Apply Biochemistry Knowledge to Understanding Primary Literature
Indicator Description:
An exam will be given that requires students to read at least three primary literature articles about enzyme function in toxicology. Student understanding of those articles will be tested by a series of 3-5 detailed questions about each article that a student could not answer if they did not understand the biochemistry of enzymes at the desired level. The scores on those questions will be summed out of 100.

Criterion Description:
It is expected that at least 80% of students will score at least 70% on the test of application of enzyme knowledge to understanding primary literature.

Findings Description:
During this course in Spring 2023, it was determined early on that this particular group of students lacked prerequisite knowledge and were not prepared for this activity. To serve their needs, the course was re-structured as it proceeded to focus more on bio-organic chemistry and exercises to fill in prerequisite knowledge. Because of this, this assessment activity did not take place.

The fact that student preparation was low enough that this drastic action was warranted means action is needed to prepare students better so they can do these high-level learning activities appropriate for graduate school.

RELATED ITEM LEVEL 3

Action - Applying Biochemistry Knowledge
Action Description:
Although the assessment was abandoned due to students having lower-level education needs that were higher priority, action to better support students' needs is needed. As part of a new first semester course all graduate students take, American Chemical Society standardized exams on five areas of chemistry will be given to gauge students knowledge. Where students lack knowledge, a mentor-assisted plan to correct the problem will be put into action.

RELATED ITEM LEVEL 1

Students Should Be Able to Demonstrate Graduate-Level Chemistry Knowledge in the Subfield Inorganic Chemistry
Learning Objective Description:
CHEM 5375 “Organometallic Chemistry” addresses the principles of bonding and reactivity in organotransition metal compounds, with a focus on their use in catalytic transformations. Two key objectives are to evaluate the mechanisms of complex catalytic reactions and to understand the reactivity of a catalyst in terms of these principles.

RELATED ITEM LEVEL 2

Student Analysis of Metal-Ligand Bonding Interactions

Indicator Description:

During a midterm or final exam in CHEM 5375, all students will be given a question asking them to analyze the metal-ligand bonding in a transition metal complex containing a π-acceptor ligand, and the effect of this bonding interaction on the reactivity of the complex. Their analysis should include the type of orbitals, their relative energies, and the direction of sigma- vs. pi-electron donation, and their drawings should show the correct orbitals in the sigma and pi interactions with the appropriate orientations and phasing. They should be able to correctly predict the effect of the π-acceptor ligand on a proposed oxidative addition reaction. This question will be scored out of 10 points, 2 points each for the orbitals, energies, direction, drawing, and effect on reactivity.

Criterion Description:

It is expected that at least 80% of the students should be able to score at least 8/10 on this question. There is no prior data for this indicator to guide whether this threshold is appropriate, but it will allow them to make a mistake on one part or a partial mistake on two parts.

Findings Description:

Findings: On the midterm exam, the criterion was not met: only 7/13 students (54%) met the desired criterion of 8/10. Most students correctly identified the π-acceptor properties of the ligand and its effects on reactivity, but several students' descriptions of the orbital interactions involved were incorrect

RELATED ITEM LEVEL 3

Action - Analysis of Metal-Ligand Bonding Interactions

Action Description:

The indicators show that students are generally learning the assignments and terminology but that their answers show that not all students are learning the fundamental concepts that underlie these assignments. Based on these results and more general observations from the course, a greater emphasis will be placed on understanding the fundamental interactions and their effects on reactivity. This emphasis will align with a broader departmental work to check and strengthen prerequisite knowledge, including a newly designed course for first-year graduate students with this goal in mind.

RELATED ITEM LEVEL 2

Student Analysis of Organometallic Catalysis

Indicator Description:

During a midterm or final exam for CHEM 5375, all students will demonstrate their understanding of organometallic catalysis by answering a question about a catalytic reaction taken from the primary chemical literature. The proposed catalytic cycle for the reaction will be presented, and students will be asked to (a) identify the reaction type for each step, or to identify the product that will form based on the reaction type that is proposed; (b) assign the oxidation state, d-electron count, and overall electron count of the intermediates; and (c) based on these assignments, predict how the catalyst activity would be affected by a proposed change in the transition metal and/or ligand. The question will be scored out of 12 points, corresponding to 9 points for the assignments of reaction types and properties, and 3 points for the analysis.

Criterion Description:

It is expected that at least 80% of the students should be able to score at least 9/12 on this question. In the most recent assessment of this type, Fall 2020, the specific point totals for this criterion were different, but 71% (5/7) students correctly identified the reaction types, 86% (6/7) correctly assigned all oxidation states and electron counts, and 71% (5/7) correctly predicted the effects of all proposed

changes to the catalyst. The proposed criterion of 9/12 points will provide a more quantitative, rather than all-or-nothing, measure of whether students are able to correctly analyze the catalytic reactions while still allowing students to make minor mistakes in these assignments.

Findings Description:

On the final exam, the criterion was not met: only 8/13 students (61%) met the desired criterion of 9/12. Most of the incorrect answers were due to students misinterpreting the proposed change to the ligand: rather than identifying the proposed change as a new ligand, they misinterpreted it as a change in the binding mode of the original ligand.

RELATED ITEM LEVEL 3

Action - Analysis of Organometallic Catalysis

Action Description:

The indicators show that students are generally learning the assignments and terminology but that their answers show that not all students are learning the fundamental concepts that underlie these assignments. Based on these results and more general observations from the course, a greater emphasis will be placed on understanding the fundamental interactions and their effects on reactivity. This emphasis will align with a broader departmental work to check and strengthen prerequisite knowledge, including a newly designed course for first-year graduate students with this goal in mind.

RELATED ITEM LEVEL 1

Students Should Be Able to Demonstrate Graduate-Level Chemistry Knowledge in the Subfield Organic Chemistry

Learning Objective Description:

Students should be able to demonstrate advanced knowledge of the field of Polymer Chemistry.

RELATED ITEM LEVEL 2

Examination of Student Understanding of Advanced Topics in Polymer Chemistry

Indicator Description:

Graduate students enrolled in this polymer chemistry course will be evaluated by two written examinations. For at least one question on each exam, students will be expected to identify the polymerization method used, the expected products, and product molecular weight for a given chemical reaction.

Criterion Description:

For examination problems, over 90% of all students will correctly identify at least two of the following: polymerization method used, expected product(s) and product molecular weight.

Findings Description:

75 % correctly identified the polymerization method used, 70 % correctly identified the expected product(s) and molecular weight. Therefore the criterion was not met.

RELATED ITEM LEVEL 3

Action - Examination of Student Understanding of Advanced Topics in Polymer Chemistry

Action Description:

The criterion was not met, with 75 % of students correctly identifying the polymerization method used, 70 % correctly identifying the expected product(s) and molecular weight. Corrective action is warranted, and student grades in the course were some of the worst we have ever had. In the bigger picture the Department currently plans to fundamentally change this course and replace it with a 'stacked' version that serves undergraduate students and graduate students in a class simultaneously (but with elevated requirements for the graduate students). When the course is reworked, the revised version will be planned with reinforcement of these skills in mind.

RELATED ITEM LEVEL 1

Students Are Able to Take Courses From at Least Three Subfields of Chemistry Each Year
Performance Objective Description:
Offer a curriculum with appropriate discipline-specific knowledge.

RELATED ITEM LEVEL 2

Graduate Course Offerings
KPI Description:
The department chair (responsible for course schedule) will set up a course schedule that will allow students to enroll in courses within the chemistry sub-disciplines.

Target Description:
Each academic year, chemistry graduate students will be able to take coursework in at least three different sub-discipline areas of chemistry.

Results Description:
In Fall 2022, one Physical Chemistry course was offered, and one Organic (Polymer) Chemistry course was offered. In Spring 2023, one Biochemistry course was offered, and one Inorganic Chemistry course was offered. Students could take courses in as many as four areas of chemistry if they took all offerings, so the target was met. This was an unusual year, usually there are multiple Organic Chemistry courses.

RELATED ITEM LEVEL 3

Action - Graduate Course Offerings
Action Description:
Since the target was met, there is no new action required. Continue to support diverse offerings that enable students to get the courses they need.

Update to Previous Cycle's Plan for Continuous Improvement Item

Previous Cycle's Plan For Continuous Improvement (Do Not Modify):

Closing Summary
Although this year all or nearly all criteria were met, there were several observations that lead to changes that could improve the MS Chemistry program or its assessment:

- CHEM 5100 "lightning talks" will have a more constrained topic selection to better support other presentations in the course as indicated in its Action Item.
- The assessment of Physical Organic Chemistry (not taught every year, so next time it is offered) will be extended to include additional performance measures as indicated in its Action Item.
- Measure of student self-assessment on course evaluations in general were greatly exceeded at the 70% (for top two ratings) level. If used for assessment in the future, a more stringent criteria is likely desired.

In addition to the above items, it is observed that student performance was not as strong as the assessment items might suggest. This is indicated by:

- For the first time ever, an MS student took three attempts to pass their oral comprehensive exam.
- For the first time ever, three different students lost good academic standing their first semester for falling below a 3.0 GPA and were terminated at the end of the second semester for remaining below a 3.0 (although all had single-semester GPAs above 3.0 in the spring term). All three were readmitted to continue after extensive discussion.

Because of those issues, it will be important for the faculty to

- discuss assessment measures that align better with grades given in courses, or to discuss whether grades are accurately capturing student performance and

- discuss whether course offerings need to be modified in the fall semester to better support the transition of students into graduate school, especially for international students who make a major adjustment culturally and academically when arriving. This may include an early warning system of some kind for students whose background knowledge is found to be less aligned with our program than evaluation of their application suggested.

Update of Progress to the Previous Cycle's PCI:

Of the changes planned from the previous year:

- CHEM 5100 "lightning talks" did have more constrained topic selection to better support other presentations in the course as indicated in its Action Item.
- The assessment of Physical Organic Chemistry (not taught every year, so next time it is offered) will be extended to include additional performance measures as indicated in its Action Item. The course was not taught this year so that remains for the next time it is taught.
- A more stringent threshold for self-assessment should be used, but this was not a common assessment measure in this year's plan so it was not carried out this cycle.

- Faculty have had ongoing discussions of grades and in-class assessments and how they relate to student performance, an issue that became even more acute when nearly half of our graduate students lost good standing and therefore their financial support when grades posted in Fall 2022
- A new course offering has been added to the fall semester each year starting in Fall 2023 (as a special topics CHEM 5385 course while we test the content for now then a full new course will be designed and approved). In that course, we will test student prerequisite knowledge and do a lot of success coaching to help students understand what they need to do to be successful in graduate school. This effort will be led by Dustin Gross but will be teach taught with input from all of the faculty.

New Plan for Continuous Improvement (MS Chemistry)

Closing Summary:

In the big picture, the findings suggested that some things assessed were on track, but some significant issues were revealed that needed attention:

- The major issue requiring action is student knowledge of chemistry prerequisite to graduate school and knowledge gained in their graduate lecture courses. This has been observed to be a huge problem, and half of the students received low enough grades to lose good standing last year. Assessments of student knowledge and skills specific to several different graduate offerings either failed to meet or barely met criteria with qualifying negative aspects to be addressed.
    - A new graduate course will be offered to students in their first semester focussed on better supporting graduate student success with assessments of prerequisite knowledge (giving American Chemical Society standardized exams in the five major areas of chemistry and were scores are low a mentor-assisted corrective plan will be undertaken) and lessons expectations of successful graduate students and best practices to get the most out o graduate school. [Dr. Gross and the other instructors in this team-taught course.]
    - Some part of this is likely due to post-COVID learning loss more generally. That part will likely improve with time, but as noted above, we are planning major action to support students moving forward with the new course and related interventions listed below.
- In general, students were able to successfully carry out research, write a Thesis Prospectus outlining their proposed research, and complete their research safely. However, a couple of changes are warranted:
    - Students are underestimating the time it takes to write a Prospectus of sufficient quality, so work needs to be done to encourage them to start and finish earlier, allowing them to get more detailed and effective feedback [Dr. Gross and all research advisors]
    - Assessment of the successful completion of the projects went well, but in the future, we should design an assessment that better measures how *safely* they work in the lab. There have not been any significant safety issues that we are aware of, but a better assessment tool may still be enlightening. [Dr. Gross, Dr. Haines]
- Student communication was evaluated as effective, generally.
    - The seminar presentation assessment findings were different from past semesters. This was mostly due to students who were not prepared for graduate studies and did not make it past their first semester. The new graduate course describe above should help with this in future semesters.
    - Although students were successful in writing and defending theses, there were issues to be addressed. As part of the new first semester graduate-student-success course described above, lessons on writing and defending the thesis will be taught. [Dr. Gross and the other instructors in this team-taught course.]

- Not all students were getting manuscripts published in the literature, so more work to try to maximize the number of students getting this experience will be needed. [All faculty.]