Program Review
Department of Chemistry
School of Science and Technology
Sonoma State University

External Reviewers:

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Executive Summary

Since the last program review, the Department of Chemistry at Sonoma State University (SSU) made significant and commendable progress in addressing recommendations and implemented substantive changes in improving and modernizing the curricula and engaging students in research-enriched learning. These time-intensive efforts include: aligning the curricula with the guidelines of the American Chemical Society, further developing the B.S. degree in Biochemistry, offering a year-round seminar program and collaborative group meetings, integrating technology into lower-division coursework, establishing a freshmen learning cohort and four-year graduation plans, and providing students opportunities to practice and present their research. The Department has grown over the last 10 years from almost oblivion to a robust group of research–active faculty, engaged staff, and refreshingly curious students. With B.S. degrees in chemistry and biochemistry as well as a B.A. in chemistry and a joint mathematics/chemistry degree and chemistry minor, the Department is working very hard to produce graduates who proceed into Ph.D. programs and the workforce while also providing service courses to the School of Science and Technology (SST) and other essential units of the university. The Department is accomplishing these tasks despite a very small cadre of senior tenured faculty, tenure track faculty, tenuous participation by part-time faculty, and limited resources.

The Department is facing both great opportunities and challenges in the coming years in its efforts to accommodate SSU's expected growth in student enrollment. These challenges are even more pronounced considering the dearth of personnel, faculty and staff needed to maintain quality chemistry, biochemistry and service programs. Addressing the challenges that the Department faces will be an evolving process requiring the collaborative efforts of the Department's devoted faculty and staff, an open line of communication among the Department, the School, and the University administration, transparent budgets, and additional support to align the level of funding with that of other smaller universities in the California State University system.

For the Department to realize its teaching and research mission and pursue its vision, the following issues need to be addressed:

- *continued curricular revisions and the implementation of online instructional aides to optimize faculty workload;*
- *timely instruction on career opportunities for graduating majors;*
- *increased attention to the service component of the program;*
- *continued assessment on the effectiveness of the majors' curricula as well as the pedagogical innovations being implemented through instructional support;*
- *student participation in SSU's School of Science and Technology research symposium and national American Chemical Society meetings;*
- *establishment of a critical mass of tenure track faculty, about 10;*
- *balance between teaching in the classroom and the research laboratory through realization of a 9 + 3 unit workload;*
- *longer periods for faculty orientation for new tenure track faculty to become intimately familiar with departmental and university resources and policies*
- *increased support of faculty in grant preparation and submission, particularly of tenure track faculty;*
- *a hiring plan for full-time temporary lecturers;*
- *an increase in the number of qualified instructional and administrative support staff;*
- *investigation of multi-disciplinary and multi-institutional collaborative research projects especially focused on the professional development of new tenure track faculty members;*
- *increase in awareness and use of available support through library and educational design resources;*
- *purchase of instrumentation for the undergraduate laboratories that is up-to-date and easily maintained;*
- *consultation with an outside expert to re-assess space utilization in Darwin Hall and possible reallocations and minor construction for more effective use.*

Detailed observations, comments, suggestions and recommendations are included in each of the following sections:

I. Goals and Objectives of the Department

II. Curricula

III. Students

IV. Faculty

V. Staff

VI. Facilities and Resources

VII. Assessment

VIII. Final Comments

I. Goals and Objectives

In pursuit of its mission to create a scholarly learning environment for students, faculty, and staff that lead to the graduation of undergraduate students who are active and life-long learners in the field of chemistry and biochemistry, the Department of Chemistry defined goals and objectives that are presented in its current program review and are summarized in Appendix 1. These are consistent with the Department's mission to develop and maintain high quality chemistry and biochemistry undergraduate degree program within the CSU system. Since certain aspects of a broad knowledge in the fields of chemistry and biochemistry are provided through course work, all faculty members are fully engaged in implementing current forms of modern pedagogy in the teaching of both their major and non-major courses. The focus on research in the degree programs is highly appropriate for students to prepare for productive and independent careers in science. The majority of the Department's graduates continues study in graduate programs or assumes independent positions in the STEM workforce, including industrial and government laboratories.

Recommendations:

1. **Continue to introduce and implement current pedagogical methods in the classroom and laboratory teaching appropriate to the student level and audience given that adequate resources are available.**
2. **Further develop assessment tools to ascertain the effectiveness of these methods.**
3. **Maintain excellent ties with alumni and the community.**

II. Curricula

A. Major Programs

The B.A. and B.S. degree programs in Chemistry and in Biochemistry (B.S.) are well-designed within the undergraduate degree requirements. The curricular changes that the Department implemented are aligned with the recommendations of the American Chemical Society (ACS) in its certification process. The combination of course work and the strong emphasis on research provide SSU's chemistry and biochemistry students with excellent learning opportunities that lay the foundation for their professional success. As in every academic endeavor, curricular innovations and modifications, further developing a new degree program (B.S. Biochemistry), adding capstone courses, and aligning the curricula with technology and modern pedagogy are very valuable efforts to improve the learning experience of the students and adapt them to the rapidly changing professional needs.

Most of the focus during our visit was on the most recent curricular changes, including the General Chemistry courses CHEM 125 A/B and its accompanying courses CHEM 120 A/B – Thinking Like a Scientist. It included the freshmen experience that places incoming freshmen into a community of learners, the introduction of research into the

curriculum through the courses CHEM 315/316 (Introduction to and Research Methods in Chemistry), and CHEM 497 (Research Seminar) as well as CHEM 401 (Senior Integrated Lab) and CHEM 402 (Advanced Synthesis and Instrumental Analysis). The latter were introduced as capstone courses in the B.A. and B.S. chemistry degree programs, respectively. The development and teaching of these courses are time-consuming and significantly increased the workload of tenure/tenure track faculty who had to return to teaching a 12-unit course load. Such a workload leaves little or no time for research, which leads to frustration of faculty who desire to strengthen the research environment in the Department and maintain their intellectual vibrancy in the classroom and the research community.

General Chemistry and Freshman Learning Community (FLC). In efforts to help incoming freshmen to find their niche and assist in their academic success, the Department participates in a university–wide effort and established FLCs for both chemistry and biochemistry majors by grouping them together in CHEM 125 A/B. CHEM 125 A/B are designed to include the content and experimentation for Quantitative Analysis, CHEM 255, that is taken by students who enroll in CHEM 115 A/B and therefore require quantitative analysis. Although the FLC is designed for majors, it is also appropriate for students interested in mathematics, science, pre-medicine and pre-pharmacy clearly indicating that the Department is also concerned about the learning of majors, who are required to enroll in chemistry or biochemistry courses. The FLC is perceived by most students as highly beneficial for their learning and has indeed created a comradery that encourages teamwork and a spirit of mutual aid. The students who we met in 125 B enjoyed the group dynamic, working with each other, and drawing on each other's strengths.

Students taking CHEM 125 A/B also enroll in the linked CHEM 120 A/B courses, "Thinking Like a Scientist". In discussions with the students and the library liaison to the Department, Ms. Caitlin Plovnik, the opinions voiced indicated that it may be too early and premature for students in the FLC to use library resources in their freshman year and to study topics, such as logic, critical thinking, the scientific method, data analysis, statistics, ethics, and science and society. The study of such topics is highly appropriate at a later stage of the students' educational experience, when they have the requisite research knowledge and have sufficient scientific training for a greater appreciation of their role in society. Ms. Plovnik also mentioned that there has been a significant drop in the access of chemistry journals and is more than willing to personally consult with students in the use of library resources and the process of literature searches, especially during the research phase of their program.

There is a small fraction of late enrollees who are not grouped into a learning cohort because of their late enrollment and therefore have to take CHEM 115 A/B and subsequently CHEM 255. At times a significant number of entering students in 125 A drop the course either because they are "shadow" majors hoping to change into a more impacted program or because they discover that chemistry/biochemistry is not well-suited for them. Based on the positive feedback provided by students on their placement into an FLC, developing a mechanism that allows the late enrollees to join the FLCs would be of great value enabling them to benefit from the collaborative learning environment.

Although students in general perceived the FLC cohort experience as highly beneficial, some Biochemistry majors felt that there was a benefit to taking courses with other majors, especially biology majors. Most chemistry majors with whom we talked had never had a chemistry course with other majors. Separation of department majors from those in other disciplines may discourage interdisciplinary interactions that are essential in today's scientific endeavors.

a. Research-Enriched Chemistry and Biochemistry Curricula. In efforts to increase the competiveness of the majors for acceptance into graduate school and chemistry and biochemistry careers, the Department developed three research courses (CHEM 315, 316, and 497) and is one of the departments in the CSU systems formally incorporating research into the degree program and making it a graduation requirement. The proscribed number of research-oriented courses in the curriculum is laudatory, especially for those students who plan to pursue a bench-targeted career. However, the questions arise if those students who love the chemistry/biochemistry subject matter, but prefer to pursue non-experimental career goals, should also engage in experimental research or if students who do not share the passion for experimental work should conduct such extensive research? Is there a way to make capstone bench research an elective rather than a mandatory course? Allowing students to choose research as an elective would also increase the elective offerings as is discussed in the next section.

b. Electives in the Curricula. Based on recommendation of the past program review, the Department started to offer electives. Currently one elective course is taught per semester on topics varying with the expertise of the faculty member teaching the course. A small group of electives has many advantages: it provides students more choices to enhance their learning experiences and pursue other areas of chemistry, ensures a broad national base for research, and allows faculty members to engage within their spheres of expertise, stay engaged in their disciplines, and remain scholarly active in their profession.

Note that several of the following recommendations are also aimed at reducing the faculty workload as it was apparent that both tenured and tenure track faculty are stretched thin due to lack of adequate resources and the time commitment that is required to engage in the multitude of curricular innovations described in the Department's self–assessment.

Recommendations:

1. **Continue the Freshman Learning Community and attempt to include late enrollees in CHEM 125 A/B.**
2. **Combine CHEM 120 A and B into one course and offer it at a time in the curriculum when students have had the opportunity to engage in research and matured to apply the topics taught in the courses to their research projects, for example, integrate the courses with CHEM 315 and 316.**
3. **Use some of the units carved out to regularly offer a series of ongoing**

elective courses that should include research.

4. **Encourage students to frequently interact with SST's library liaison to search the current literature and use the library resources, especially when pursuing research activities.**

B. Service Courses

As is the case in any other chemistry department in the CSU system, SSU's Department of Chemistry supports many other majors, including biology as one of the larger majors in SST. Although no specific issues were brought up by the Department about the teaching of its service component, it constitutes a large portion of faculty WTUs and consumes considerable amounts of time and attention. In conversations with Dean Lynn Stauffer it became apparent that the Department must find a better balance between the major and service courses, which requires time and effort on the part of the chemistry faculty and adds to their workload. There are ways to alleviate the faculty workload in these service courses and still maintain the quality of instruction in both the major and non-major courses.

Some fundamental changes could alleviate the pressure on faculty workload.

Recommendations:

1. **Optimize resources by eliminating the "Introductory General Chemistry" course, CHEM 110, that is designed for students who are ill–prepared for university-level coursework. Following the practice at other CSU campuses, this course is more appropriately offered at nearby community colleges.**
2. **Investigate the use of mandatory online homework programs provided by publishers that have been proven to enhance the motivation of non-majors and majors alike to engage in the learning process.**
3. **Continue to implement current pedagogy into the formal classroom teaching to optimize learning opportunities for all students. Find the best tools available for assessing the effectiveness of these methods.**

III. Students

The Department currently enrolls about 150 majors with 42 B.S. Chemistry majors, 83 B.S. Biochemistry majors, as well as 25 B.A. Chemistry majors and 15 Chemistry minors. The impressions and observations gathered on the degree programs, students' learning experiences, faulty, staff, and the general climate in the Department were drawn from meetings with five groups of undergraduate students – students in the FLC, students in the capstone courses, students participating in faculty-sponsored research, students involved in the Chemistry Club, and alumni during both days of the visit. Overall, the students projected a highly positive view of the Department and their undergraduate learning experiences. Uniformly they praised the faculty, their work ethic,

availability, and dedication to student learning as well as the helpfulness of the Department staff. They also enjoyed their research experiences, and some of them desired exposure to research earlier in the curriculum.

The students were generally in agreement about issues that could improve the program, the well–being of the Department, and the overall quality of the undergraduate learning experience. Among these were: nonfunctional and antiquated instrumentation, cramped working and research space, and, with exception of the McNair Scholars Program, very limited financial support for student research. Students also noted that due to the lack of adequate instructional support for instrument maintenance (further discussed in Section VI), the students engaged in research had in general a better educational experience than the non–research active students due to their extensive hands–on instrument training in the research laboratories. In general, students were also not well aware about career development opportunities and resources available to them through professional organizations or on-campus units, and about opportunities to present their research. An issue was also raised relating to the lack of sensitivity regarding students with disabilities.

Recommendations:

1. **Provide students opportunities to engage in research earlier in the curriculum and seek funding for student research by, for example, teaming up with the local chemistry and wine industries.**
2. **Include a career orientation aspect to the seminar course as well as more opportunities for seminar presentations along with peer critiques.**
3. **Encourage students to use the professional development links available through the ACS or on-campus resources for career counseling and employment opportunities as well as other pertinent topics.**
4. **Encourage students to continue to interact with other majors during Geek Week and seek research collaborations with other departments.**
5. **Encourage student researchers to continue to present their work at the SST annual research forum as well as local, regional and national meetings, including those of the ACS.**

IV. Faculty

Faculty recruitment, permanent and temporary, is a high priority for the Department. While recent faculty hires have been of high quality and are invaluable to meet some of the curricular goals set forward by the Department, the number of faculty members needed to teach the undergraduate and service courses and laboratories and provide research opportunities for students is insufficient to accommodate the continuing growth in student enrollment. Ideally, funds should also be provided to hire full-time, one- to two-year contract lecturers, which will enable all tenured/tenure-track faculty to continue to further develop undergraduate courses, advance their research productivity, pursue extramural funding and sabbatical leaves, and engage in other professional

development activities.

A. Faculty Concerns – Hiring of Tenure-Track and Temporary Faculty. The Department employs a total of seven full time tenure/tenure track faculty (four faculty members in the rank of Professor, one in the rank of Associate Professor and two in the rank of Assistant Professor) and five Ph.D. level part-time faculty members. This reflects a disparity among the professorial ranks necessitating the hiring of more assistant professors. Some of the tenured/tenure track faculty members have active, externally-funded research programs, which are important to enhance the undergraduate experience and provide an invaluable opportunity for integrating the excitement of scientific discovery into undergraduate education. The desire of the faculty to remain research–active is outstanding and commendable. However, a cadre of well–qualified, part–time faculty must be available to support this research activity and maintain the quality of instruction in both the majors and non-majors undergraduate programs. There seems to be a misunderstanding between the SSU hiring practices and CSU policy. Not only the Department chair, but also the Dean and the Provost are under the impression that one– and two–year full-time temporary faculty appointments are neither desirable nor possible. There is also a misconception that if a temporary appointment is made for one year, the temporary faculty member must be re-hired for a 30 unit load. CSU policy allows for one– and two–year full-time appointments. Considering the expense of moving from another location and the cost of renting/living in the Sonoma area, a minimum of a year-long contract is required to attract temporary faculty who are committed to the Department and the University and who will actively contribute to the educational goals of the Department.

B. Support for Faculty Research. Discussion with tenured/tenure track faculty members revealed that one of their main concerns is to balance teaching and research and find the resources to remain research–active. It is well known that undergraduate research benefits students educationally, professionally, and personally. It was refreshing to experience that even the non–tenured faculty are starting to conduct small–scale research. However, to support a research–enriched learning environment, resources need to be provided to reduce the teaching loads of research-active faculty to a 9 + 3 unit load, where faculty devote the "+3" units to mentor undergraduate student researchers, write grants to secure extramural funding, and submit manuscripts for publication, which is a requirement for attracting grant funding. Extramurally–funded faculty, who substantially contribute to indirect cost recovery, should be allowed to buy out some of their classroom teaching time to conduct research that remains competitive.

C. Start-up Packages and Assistance in Grant–Writing. Other serious concerns of the faculty involved funding for new tenure–track hires. Ideally start–up packages should be increased to align with those of other smaller CSU universities to be competitive in hiring excellent faculty. This is in the perview of the Dean, the Provost and the higher administration. We encourage a more detailed consideration of this matter with the Department and an open line of communication by encouraging the Department to clearly articulate its needs. In addition to start–up funds, the lack of attention paid to assisting new faculty members with grant proposals is short-sighted. In a smaller institution, such as SSU, grants and contracts are essentially the only

way that an active research program can be established and maintained by fledging and supporting faculty members and students. The admission that only 0.3 of a staff position is available for pre-award assistance is alarming, especially in light of the excellent staffing for post-award monitoring.

Until the Department is able to hire an adequate number of tenure-track faculty, it should consider reaching out to outside experts in certain disciplines currently not available on the present faculty to augment the variety of undergraduate courses offered. For example, the Department could reach out to the wealth of scientific talent available in the greater Bay Area, local industry, the Buck Institute of Aging in nearby Novato, and/or government laboratories, including NASA, Lawrence Livermore and Lawrence Berkeley, where possible temporary or adjunct faculty could be recruited. Also, utilizing postdoctoral fellows from nearby institutions, including the University of California in Davis, Berkeley and San Francisco might be another source of lecturers in an undergraduate laboratory course. There are usually a number of postdoctoral fellows whose career goal is to find employment in an academic institution. The teaching experience that they will gain will be a valuable asset to their resumes.

D. Tenure Policy. Although the criteria for tenure and promotion at SST do not require a specific number of peer-reviewed publications, the departmental criteria do require two publications. Considering the constraints on budgets, grant preparation, instrumentation, faculty time, and related aspects, it could be feasible to consider other criteria that are tenure-worthy, such as proprietary grants, textbook or educational tool creation, curriculum development, and ongoing service grants, such as those for K-12 teacher training. There is more than one way to contribute to the advancement of science in a meaningful way.

Although the new tenure track faculty lauded the mentorships that they are provided by their tenured colleagues and the Department chair and praised their willingness to engage in conversations, they were not intimately familiar with available resources in the Department, the School and the University, tenure-track criteria and policies, preparation of the Working Personal Action File, and departmental expectations to serve on SST and University committees. Thus, there is a need to communicate regularly and more often with junior faculty to heighten their awareness of available resources and expectations. Such information exchanges are also of great value for tenured faculty to ensure broad dissemination of resource and policy information, including accommodations of students with disabilities.

Recommendations:

1. **Increase the number of tenure track faculty to at least 10.**
2. **Employ temporary faculty on one– to two–year full-time contracts to help teach non-majors courses and lower division courses in the major.**
3. **Allow faculty to remain research active and conduct competitive research by adjusting their teaching loads to the 9 + 3 unit model. Allow extramurally-funded faculty to further reduce their teaching loads by buying out their time.**

4. **Increase staffing to assist all faculty in grant preparation and development paying increased attention to the needs of new faculty.**
5. **Initiate outreach efforts to national laboratories and institutes and the local industry for establishing visiting professorships and hiring part-time faculty.**
6. **Consider other externally validated criteria for tenure and promotion.**

V. Staff

The Department employs a very dedicated staff – one administrative coordinator (0.5 position), an instrument technician (0.5 position), and a full-time chemistry stockroom manager. They are team players who go out of their way to accommodate the student learning experience by a rigorous adherence to the preparation of laboratory reagents and materials and instrument repair. They try their best to maintain instrumentation in working condition in support of the instructional and research programs. However, there are simply too few staff members to keep the Department fully operational. One laboratory technician cannot possibly be present in several places at once providing stockroom window assistance, ordering chemicals, repairing a malfunctioning spectrophotometer in a general chemistry laboratory, and trouble-shooting a problem with a major piece of research equipment. The one SST "instrument technician" available splits his time among the physics and chemistry departments and admits that he is more experienced in maintaining physics equipment than in repairing and trouble-shooting chemistry instruments requiring programming, standardization and providing detailed operational instruction for students. To maintain outdated equipment adds to his level of frustration. Thus, individual faculty members most often assume the responsibility for routine instrument maintenance. This detracts from their main duties of teaching in the undergraduate program and guiding undergraduate students in their research projects. One of the greatest benefits of the SSU's chemistry and biochemistry degree programs is the personal attention given by faculty to their students. One of the greatest deficits is the time taken away from students because faculty members have to repair and recalibrate "work horse" instruments. Thus, a high priority for the Department should be to hire an instrument technician and additional stockroom personnel who have the expertise in repairing most of the instruments and perform routine checks on instruments outside of the specialized research facilities and guarantee the smooth operation of the stockroom and the teaching laboratories.

Currently the Administrative Coordinator, shared with the Physics Department, is assuming at least a full position's worth of duties that can be extensive in a laboratory-oriented department such as chemistry. We strongly encourage that the Administrative Coordinator will become a full-time employee in the Department to maximize department operations and reduce the workload of the Chair.

Recommendations:

1. **Hire a full-time instrument technician for chemistry or hire another support technician with expertise in maintaining instruments complementary to that of the current support technician.**

2. **Add an additional full-time stockroom position to optimize support for both the teaching and research laboratory operations.**
3. **Use standardized forms in routine use at other CSU campuses for the hiring and evaluation of support staff that list responsibilities and time allotments for each responsibility. If expertise in this area is not available at SSU, advise SSU's Human Resources to contact other CSUs for their forms and methods and to develop a responsible mode of accountability for its employees.**
4. **Increase the academic coordinator's position to full-time to optimize the undertakings and operation of the Department.**

VI. Facilities and Resources

The efforts of faculty and staff to manage the educational programs, promote a safe working environment (all students in the teaching laboratories wore protective clothing and eye protection), and reinforce prudent laboratory practices are commendable in particular in view of the limited resources and space available. Almost all science departments in the CSU system desire more space for instruction and research. However, the situation at SSU's Department of Chemistry is barely adequate for its role in providing essential coursework for the university. Thus, to optimize operations and to continue practicing chemical safety changes are needed.

***A. Teaching Laboratories*.** Not all of the teaching laboratories are located in a centralized area easily accessible to instructional support staff. Some laboratories are located in another building. This is not only undesirable for optimizing support, but is also dangerous in terms of chemical safety practice as stockroom personnel will not be immediately available to assist in the event of an accident.

***B. Research Laboratories*.** Research laboratories house equipment used for both the instructional program and student/faculty research projects. While this consolidation of resources is not unusual for CSU chemistry departments, there are too many antiquated and nonfunctional pieces of instrumentation and just general clutter in these laboratories. The old equipment (white elephants) should be discarded and replaced with more reliable, recent models. Broken, but still useable instruments must be repaired in a timely manner to avoid significantly impacting the instructional and research programs. Chemicals, including solvents, sitting on top of benches should be properly stored in chemical safety cabinets.

C. Allocation of Space. The allocation of research space is not optimized. For example, faculty and their students share benches in several research laboratories, which leads to situations where chemical hygiene and safety is not viewed as a shared responsibility. For safety reasons, every effort should be made to allocate space, such that sharing is avoided to strictly enforce safety practices.

It would be a valuable use of limited funds to hire a space utilization consultant, an objective observer, to catalog useable space in Darwin Hall and other buildings adaptable to laboratories and offices and make recommendations for reallocation of

space within the school and/or minor remodeling to optimize existing space.

Recommendations:

1. **Create an updated list of equipment to assist in the rationale for requesting instructional support, replacement and currency of instrumentation listing the following information:**
   - **model and approximate date of acquisition**
   - **price**
   - **location**
   - **functional or nonfunctional**
   - **use for research, instruction, or both**
2. **Request SSU's Environmental Health and Safety to inspect all laboratory spaces and make recommendations for storage of chemicals and placement of laboratory equipment and regular safety training for students, staff and faculty.**
3. **Engage an outside consultant to assess space utilization by the Departments occupying Darwin Hall and other laboratory spaces. Follow-up may require reassignment of space and/or minor remodeling to better utilize existing space.**

VII. Assessment

In spite of its limited resources and the time constraints of the small number of faculty members, the Department has started to make serious efforts in assessing the learning outcomes of its students. Its willingness to devise, implement and analyze the effectiveness of its programs is commendable clearly revealing that the Department is dedicated to teaching and learning. Assessment of learning is an essential part of every instructional program and meaningful assessment plans are increasingly expected at both the college and university level. Quizzes, exams, orals, finals, and reports are standard methods for ascertaining levels of subject mastery. However, it is the objective analysis of the results that is at the heart of the matter: Are students learning the subject matter presented and are the instructors guiding them adequately and effectively in the learning process?

The Department has been in a continuing process of using various tools for assessing student learning. It developed an exit exam to assess the learning outcomes of its graduates. Following a detailed analysis, the faculty correlated various student learning experiences in the program. Currently they are planning for the third iteration of the exam. However, it should be noted that the results of the assessment may not yet be statistically significant due to the small number of participating students. The exit exam has a strong General Chemistry focus, which is insufficient to assess student learning outcomes in all aspects of the degree programs. Thus, the faculty members are encouraged to critically review and refine the exam or use an exam developed by the ACS for better program and learning assessment.

The ACS provides booklets for the construction of exam questions as well as various

levels and lengths of standardized tests. The Department has used the ACS Placement Tests for freshman courses and other ACS tests for 2nd semester and year-long general chemistry sequences. In addition it has also kept records on graduate placement exam scores, evaluations of student supplemental instructors, and the status of alumni in graduate schools and industry. For reason of data confidentiality and identity protection, we recommend the use of other methods of identification when reporting the results from the Graduate Placement Exams instead of using students' names. Anecdotally, we were told that 30–40% of the students earn D/F grades in General Chemistry. This information should be retrieved from the SSU People Soft System, and the full grade range should be considered in efforts to improve student retention.

The faculty teaching the General Chemistry B1 courses participated in the GE subcommittee assessment of its Learning Objective using embedded questions.

As part of the collaboration in the NSF–funded WIDER program whose chief goal is to create supportive environments for STEM faculty members to substantially increase their use of evidence-based teaching and learning practices, several faculty members have undergone observation and constructive critiques of their teaching methods in collaboration with Anne Steckel, the Director of Educational Design and Curricular Innovation. She was impressed with the skills and expertise of the faculty representing the Department.

Recommendations:

1. **Continue and revise the program assessment plans given that assigned time is provided for participation and analysis. Continue to assess the learning outcomes in General Chemistry using the ACS-developed standardized tests.**
2. **Consider requiring a math component as pre-requisite for students enrolling in chemistry courses as the analysis placement exam results has revealed that readiness for university-level chemistry depends mainly on skills in algebraic manipulations.**
3. **Re-evaluate using the in-house developed exit exam to assess the overall learning outcomes of the Department's graduates. Consider using the Diagnostic of Undergraduate Chemistry Knowledge (DUCK) examination to assess the learning and knowledge of the Department's graduates.**

VIII. Final Comments

We would like to express our sincere thanks to all who participated in this review, particularly:

- all Department faculty and staff members as well as the undergraduate students for their time and efforts to provide insightful views of the Department;
- the Chair Dr. Jennifer Lillig and Dr. Steve Farmer for preparing a thorough self-evaluation and assessment;
- the undergraduate students and alumni who provided highly informative, enthusiastic and insightful information on the Department, the Freshman Learning Community, capstone laboratories, undergraduate research, and the student club activities;
- members of the administration, in particular Provost Andrew Rogerson, Dean Lynn Stauffer of the College of Science and Technology, Associate Vice President for Academic Affairs Elaine Sundberg, for their perspectives on the Department, the undergraduate program and the long-term vision for the University and their readiness to increase the rapport with the department;
- members of the Office of Research and Sponsored Programs – Associate Vice President Matt Benney and Projects Administrator Carol Hall and Senior Director Jeff Wilson for providing insights in pre- and post-award operations;
- University Librarian Caitlin Plovnik for her efforts and willingness to assist students, faculty and staff in the active use of library resources;
- Director of Educational Design and Curricular Anne Steckel for her efforts in assisting all Department faculty members to evaluate their effectiveness in teaching, innovating the curricula and introducing technology.

APPENDIX 1

Mission: SSU's Department of Chemistry

The Department's mission is to create a scholarly learning environment for students, faculty, and staff that lead to the graduation of undergraduate students who are active and life-long learners in the field of chemistry. The Department identified seven major goals and measurable objectives and made significant advances in achieving them (see Table below).

Goals	Measurable Objectives	Objectives Met
1. Deliver a modern curriculum in both content and pedagogy that extends beyond the standard classroom experience.	A. Offer electives in current topics (3-6 units) in line with CSU-wide practice	yes
	B. Follow ACS guidelines for course offerings	yes
	C. Offer a year-round seminar program.	yes
	D. Utilize current educational technologies and techniques to deliver the curriculum	yes
	E. Integrated capstone experiences with thesis	tabled
	F. Student access to modern instrumentation and instrumentation class	yes, but limited
2. Provide realistic, cutting-edge, and quality year-round research training.	A. Faculty success in publishing & securing funding	yes
	B. Faculty and student presentations	yes
	C. Offer year-round seminar program	yes
	D. Departmental success in instrument acquisition and maintenance	partly – lack of support
	E. Financial support for undergraduate research, proposal writing, technician, matching funds.	no
	F. Students success in entering graduate school and/or the workforce	yes
	G. Regularly scheduled group meetings	yes
3. Help students prepare for their future in a manner that will allow them to be successful	A. Students' success in entering graduate school or the workforce	yes
	B. Students' success in completing an independent laboratory project	yes
	C. Students present their laboratory work in oral, written, and poster formats.	yes
	D. Opportunities for students to hold TA/SI/peer-instructor positions with proper training	yes
4. Nurture students and mentor them through individualized and honest guidance for their scholarly development.	A. Mandatory annual advising appointments for all chemistry majors	yes
	B. Accessibility of faculty and staff to students	yes
	C. Hold regularly scheduled group meetings	yes
	D. 4-year academic planning for entering students	yes
	E. Maintain and support a chemistry club – 20 members; ACS affiliate chapter	yes
	F. Information and knowledge on career opportunities	yes, but rather limited
5. Engage in meaningful conversation about	A. Hold annual curriculum and programming retreats	yes
	B. Maintain a yearly seminar program	yes
	C. Obtain resources for faculty to attend workshops	yes

and provide support for professional development of faculty and staff.	and conferences in teaching and research	yes
	D. Training opportunities for staff	no
	E. Assigned time for writing research proposals and publications	no
	F. Adequate space for instrumentation, research, faculty offices, teaching laboratories, stockroom, student club, Department office	no
6. Have a high quality Department in terms of students, faculty, staff, available resources, and modern facilities and instrumentation	A. Obtain a high-field NMR (NSF MRI) and LC-MS	yes
	B. Obtain an NSF-REU – three unsuccessful attempts	no
	C. Hire an instrument technician - lack of funds	no
	D. Implement a minimum "C" grade requirement in all chemistry courses for majors	tabled
	E. Provide honest, thorough performance reviews for all faculty and staff – new RTP guidelines and guidelines for staff	yes
	F. Utilize CHEM 125A/B as a tool ("Freshman Experience") for preparing chemistry majors for upper division coursework	yes
	G. Partner with local high schools and JCs to facilitate the transfer of students – Summer High School STEM Internship Program (SHIP) through collaboration with SST; students become ambassadors to communicate their experience. New NMR instrument providing new opportunities to connect with local community colleges. Department began a public outreach effort where faculty member speak at local High Schools.	yes
	H. Hold advising open-houses for potential majors – realized by participation in SSU's Seawolf day, advising of interested incoming freshmen	yes
	I. Allow majors to repeat a total of three chemistry classes; meet with the curriculum committee to discuss academic plans as route to success	yes
	J. Require an overall 2.0 GPA in the chemistry major for graduating majors	yes campus policy
7. Work collaboratively, work as a team, and maintain close working relationships within our chemical community and the community at large.	A. Partner with local schools/industry (Themochem) – not enough manpower	yes, but limited
	B. Obtain an NSF-REU – 3 attempts made	no
	C. Hold annual gatherings for members of the chemical community – limited to wine seminar event due to lack of manpower	yes
	D. Provide support for the Chemistry Club – sales of laboratory manuals.	yes
	E. Hold an annual team-building exercise for faculty/ staff – annual retreat and parties	yes
	F. Provide opportunities in the classroom for students to solve problems together	yes