Pittsburg State University's Academic Program Review

Departmental Information

1. Program Identifiers

College:	Arts and Sciences			
Department:	Chemistry			
Degree Programs:	**CIP Code**	**Degree**	**Program Name**	**Options**
	400501	**Bachelor of Science**	**Chemistry**	**Option I, Option II, Pre-Pharmacy, Pre-Engineering**
	400501	**Bachelor of Science in Education**	**Chemistry**	**No Emphasis**
	400501	**Master of Science**	**Chemistry**	**No Emphasis**

2. Department Profile

Student Information	FY/02	FY/03	FY/04	FY/05	FY/06
Number of Program Majors:					
Lower	56	45	34	41	57
Upper	25	24	36	28	33
Graduate	6	7	7	7	10
Number of Graduates:					
Bachelor	7	4	10	10	8
Masters	5	1	3	2	4
EdS					
Retention Rate:	62.5	83.33	76.47	75	
ACT Scores of Majors:	24.7	25.6	25.1	26.1	24.6

Note: Retention rates may be distorted by the inclusion of Pre-Pharmacy and Pre-Engineering majors in the lower level enrollments. Also, the number of terminally qualified faculty below seems to be in error. We have had seven terminally qualified faculty since 1996. There was no change in FY/04 as indicated.

Faculty Information	FY/02	FY/03	FY/04	FY/05	FY/06
Total FTE	7	7	7	7	7
Number T/TE	6	6	6	6	6
Number terminally qualified	6	6	7	7	7
Number Non-T/TE Full-Time	1	1	1	1	1
Number Non-T/TE Part-Time	1	0	0	0	0

3. Departmental Resources

Resources	FY/02	FY/03	FY/04	FY/05	FY/06
Salaries and Benefits	572,914	604,804	582,674	648,095	672,358
OOE	37,336	45,765	61,975	50,418	56,217
External Funding – Grants, PD, Fees, etc.	24,625	40,255	32,737	79,200	75,393
Total	634,875	690,824	677,386	777,713	803,968

Note: The OOE allotment of $36,111 has not changed in decades. These OOE expenditures include purchases of new equipment funded by "Student Fee" tuition increases and allotments for student workers.

External funding sources:

Siam: Educators in Chem. Fellowship	**2006 = $ 5,000**
Shirley: Biomass Grant	**2002 = $14,834**
	2003 = $30,464
	2004 = $ 9,439
McAfee: Functional Protein Analysis	**2002 = $ 9,791**
	2003 = $ 9,791
	2004 = $12,298
	2005 = $35,577
	2006 = $52,893
Paul: NSF-ROA/DoD-MURI	**2004 = $11,000**
	2005 = $12,123
	2006 = $ 7,500
ONR (Nanomaterials)	**2005 = $31,500**
	2006 = $15,000

4. Departmental SCH

Credit Hour Production	FY/02	FY/03	FY/04	FY/05	FY/06
Lower Division	1,940	1,975	2,009	2,067	2,365
Upper Division	1,283	1,288	1,234	988	1,142
Graduate	145	136	177	170	196
Total	3,368	3,399	3,420	3,225	3,703

Note: 3,703 SCH / 7 FTE = 529 SCH/FTE.

5. Cost per Credit Hour

Credit Hour Production	FY/02	FY/03	FY/04	FY/05	FY/06
Lower Division	121.70	129.92	124.51	146.65	132.99
Upper Division	214.19	228.65	219.14	258.11	234.06
Graduate	685.16	731.43	701.01	825.67	748.74

6. Diversity

Explain what activities you have undertaken to increase faculty and student diversity within the department.
The Chemistry faculty is remarkably diverse, including the only African American professor on campus, a woman chemist, plus two international faculty (three counting Dr. Irene Zegar again). We have just completed another search which will add yet another international professor to our rolls. These successes in encouraging diversity can be attributed to a diligent strategy of recruiting the best people we can, regardless of background, and we are very fortunate to have found such talented people. Credit must be given to administrators who had the foresight to negotiate effectively, to be flexible, and to do what needed to be done to make this happen. We also attempted to hire another female in our last search, but the salary range was not competitive. Our percentage of female students has always been well above the national average, both at the graduate and undergraduate level. This also most likely reflects a positive and encouraging attitude by the faculty, and perhaps a tendency for female majors to stay in this area.

7. Instructional Technology

Explain how your department uses instructional technology to enhance teaching and learning.
Most of the Chemistry faculty at least use presentation software (Power Point) and classroom management software (Black Board), Excel for record keeping and statistical analysis, and email. Several also use eInstruction RF student response systems (clickers) to facilitate feedback interaction with large classes. Various computer interfaces are used in our lab classes to collect, analyze, and present data. Several of the laboratory classes routinely use Computer Based Lab (CBL) units to collect measurements and transport them to the computer lab for download and further processing. The Department also maintains an effective and informative web page in compliance with campus standards and directives.

Degree Program Review

1. Program Identifiers

College:	Arts and Sciences				
Department:	Chemistry				
Degree Program:	**PSU Degree Code**	**CIP Code**	**Degree**	**Program Name**	**Options**
	DA1	**400501**	**Bachelor of Science**	**Chemistry**	**Option I (ACS Certified)**
	DB1	**400501**	**Bachelor of Science**	**Chemistry**	**Option II (Not ACS Certified)**
	DB2	**400501**	**Bachelor of Science**	**Chemistry**	**Pre-Pharmacy**
	DB3	**400501**	**Bachelor of Science**	**Chemistry**	**Pre-Engineering**

Note: Pre-Pharmacy and Pre-Engineering are not really degree programs. Students in these programs transfer from PSU to either pharmacy or engineering schools prior to even reaching the upper level. Consequently, PSU does not award degrees to any students in these categories. However, they do receive advisement from the Department and take many of the same introductory service classes as those required of our majors. Inclusion of these programs in the lower division enrollments distorts the reported retention rates and ACT scores.

2. Faculty That Support Program

Pavlis, Siam, Hamlet, Shirley, Paul, McAfee, Zegar

3. Number of Majors

	FY/02	FY/03	FY/04	FY/05	FY/06
Lower Division	50	44	30	40	56
Upper Division	24	24	34	25	30
Graduate					
Total	74	68	64	65	86

4. ACT scores of majors

	FY/02	FY/03	FY/04	FY/05	FY/06
Ave ACT Score	25.95	26.45	26.7	27.55	27.55

5. Degrees Awarded

	FY/02	FY/03	FY/04	FY/05	FY/06
	6	4	10	10	8

6. Program Changes Since Last Review

The major program change was the addition of CHEM 575 Biochemistry I to the ACS certified Option I program in response to an initiative by the American Chemical Society to explicitly include the subject of biochemistry in their certification requirements. To keep the total number of courses fixed, this addition was accompanied by a reduction in the number of chemistry electives.

We also legislated a series of changes to the General Education package, which had previously only included CHEM 105/106. These changes mainly affected students whose majors required General Chemistry but who needed some remedial preparation. The vehicle for such help has essentially been replaced by a course designed for Nurses and Pre-Professional programs, such as Dental Hygiene. We first separated the survey course of general chemistry needed for the Nursing program (105/106) from the remedial instruction for students who have not had chemistry in high school, creating a new course for that purpose alone (112/113). Only the 105/106 met General Education goals. Then we created an alternative survey class focusing more on biochemistry and organic (107/108) for dental hygiene majors at Fort Scott Community College. Since General Education requirements have since changed, this course also meets Gen. Ed. goals.

7. Program Foundations

a. Program description:

Chemistry is an essential component of the curriculum for a comprehensive university and is fundamental for all the sciences, medicine, engineering, and most technology majors. A baccalaureate program in chemistry naturally leads to careers in either chemical laboratory, medical, chemical education, or industrial settings requiring advanced technical problem solving, such as process development, forensic analysis, diagnostics, environmental protection, or collaborative efforts with chemical engineers, physicians, or other scientific researchers. As such, it is an area of study offering serious content and critical skills that actually benefit the state and nation, as well as the individual student, which deserves to be supported and promoted. Inclusion of the chemistry major on campus also stimulates technical experiences for others sharing their classes and promotes critical thinking skills.

b. Accreditation status – if any: (If not accredited explain why.)

The Option I B.S. degree program is certified by the American Chemical Society. Option II is not. This is a relatively rare sort of accreditation. PSU has the only certification in Kansas in an institution that does not have a Ph.D. program. Many of the 639 ACS certified programs are at institutions that also offer the Ph.D. in Chemistry (221 out of about 3,000 institutions total).

Four items in the ACS accreditation guidelines require continued attention:

"… The chemistry program should be administered by a chemistry department organized as an independent unit with control of an adequate budget. … where the department is administered as a division of a larger unit, it is essential that the chemistry faculty have enough autonomy and budget control to carry out these functions and responsibilities within the division. …"
This suggests that the merger with the Physics Department will not endanger Certification as long as autonomy of the Chemistry program is maintained.

"Supporting Staff Requirements: Administrative support, stockroom, and technical staff should assist faculty members with supporting activities, permitting faculty members to devote their time and effort more fully to academic responsibilities and scholarly pursuits."**The recent upgrading of our stockroom person to Chemist I, based on the need for preparing samples and performing tests while supervising student instructors, should help insure that we meet this requirement.**

"Teaching Contact Hour Restrictions: Under no circumstance should a teaching load exceed 15 contact hours per week in any semester or quarter, and significantly lower loads are strongly recommended by the Committee. **We currently meet these load limits, with sufficient GTAs to help in the lab classes. With two contact hours for every credit hour, we use converted hours to structure assignments that comply with both PSU and ACS guidelines.**

Library Requirements: Essential to an approved chemistry program is a good library where faculty and students have access to books and periodicals and where adequate support for database searching is available. …" **The library requirements are being met by a combination of a recently acquired electronic data base including about 35 ACS journals and student access to some remaining private faculty subscriptions.**

c. Program goals and objectives:

Option I: American Chemical Society approved degree. This sequence is primarily designed to prepare undergraduate majors for graduate study leading to the Ph.D. and is the preferred degree for those intending to immediately work as chemists. It includes a curriculum required by most nationally recognized advanced degree programs as certified by the American Chemical Society.

Option II: This sequence prepares students, in both theoretical and practical laboratory experience, for immediate employment in specialized chemically related careers. A minor or second major is required to complete qualifications in one of the following emphasis areas: Biochemistry, Pre-Medicine/Pre-Medical Profession, Environmental Chemistry, Polymer Chemistry, or Chemical Sales and Service.

Both Options are designed to produce graduates who …

GOAL 1: … understand the theoretical and mathematical basis of our current understanding of chemical processes in organic, inorganic, physical, and bio- chemistry.

Objective 1: Accurately and rigorously apply fundamental mathematical principles and notation, including algebra and differential and integral calculus.
Objective 2: Demonstrate principles and solve fundamental problems in inorganic chemistry, including atomic structure, periodic properties, molecular bonding, reactions, and gases.
Objective 3: Demonstrate principles and solve fundamental problems in kinetics, equilibrium, acids, bases, and thermodynamics.
Objective 4: Demonstrate principles and solve fundamental problems in organic chemistry, including bonding, structure, nomenclature, mechanisms, and reactions.
Objective 5: Demonstrate principles and solve fundamental problems in analytical chemistry, including gravimetric, volumetric, spectroscopic, chromatographic, and electrochemical analyses.
Objective 6 (Option I ONLY): Demonstrate principles and solve fundamental problems in biochemistry, including structure and functions of enzymes and other proteins and major metabolic pathways of carbohydrates, lipids, amino acids, and nucleic acids.
Objective 7 (Option I ONLY): Demonstrate principles and solve fundamental problems in advanced physical and quantum chemistry.

GOAL 2: …are able to use scientific instrumentation and safe laboratory procedures to design, conduct, and interpret basic scientific experiments.

Objective 8: Find and interpret relevant research and current theoretical understanding needed to plan, conduct, and interpret basic experiments in the physical sciences.
Objective 9: Formulate a testable scientific hypothesis.
Objective 10: Select and safely configure laboratory instrumentation to generate data relevant to a scientific hypothesis.
Objective 11: Use computers and appropriate software or programming language to analyze, reduce, and graphically present experimental data.
Objective 12: Based on a proper analysis of experimental data, draw an appropriate scientific conclusion.

GOAL 3: … are able to communication scientific ideas and information effectively using modern digital technology.

Objective 13: Organize and present scientific information in a written report using appropriate notation, format, and citations.
Objective 14: Organize and present technical information to a live audience using presentation software and effective speaking techniques.
Objective 15: Use technology to communicate informally with others in the field, for example, using email and web pages.

8. Curriculum

a. National/professional guidelines: (How does the curriculum align with national/professional guidelines?)

Option I conforms to ACS guidelines as certified by the ACS investigating committee. Option II allows substitutions of other upper level chemistry courses for Physical Chemistry II and Analytical Chemistry, particularly Biochemistry, thus making Option II ideal as a second major for Biology majors.

b. Curricular alignment with external constituent needs:

The professional studies component insures a thorough grounding in chemistry fundamentals in preparation for many employment possibilities in Kansas and nearby states. Electives and independent research experiences, some through cooperative involvement with area industries, small contract research companies, Business and Technology Institute researchers, and research programs at other universities, further provide students with ample research experiences for graduate study or to make them attractive employees for a broad spectrum of chemistry related careers.

c. Course sequencing: (Show the sequence of courses students should follow to graduate in 4-years.)

Option I:
Year 1: Calculus I , General Chemistry I
Calculus II, General Chemistry II, Engineering Physics I
Year 2: Calculus III, Engineering Physics II, Programming
Organic I, Analytical
Year 3: Organic II, Biochemistry I
Physical Chemistry I, Inorganic, Instrumental Analysis
Year 4: Electives, Physical Chemistry II
Electives, Senior Colloquium

Option II:
Year 1: Calculus I , General Chemistry I
General Chemistry II, Engineering Physics I
Year 2: Engineering Physics II, Programming
Organic I, Analytical
Year 3: Organic II, Biochemistry I
Physical Chemistry I
Year 4: Electives
Electives, Senior Colloquium

d. Program delivery methods:

Introductory courses include both a lecture component for theory and mathematics plus a laboratory component in which hands on practice is used to illustrate chemical principles and provide familiarity with measurement techniques and modern equipment. Upper level elective options also include projects and guided research classes, in which a particular system or approach is expanded to fill an entire semester. Lecture classes primarily focus on solving drill problems, both in class and as homework assignments, with examinations to test the skills and knowledge developed. Some classes also include research projects in for which students read literature and use library resources to generate a written report. The laboratory classes focus on working with standard laboratory devices and instruments to perform experiments, analyze data, quantify measurement errors, draw justified conclusions, and prepare a written report.

9. Assessment of Student Learning: (From annual assessment report.)

a. Specific desired student outcomes: (What specific knowledge, skills, and experiences should a graduate of this program possess?)

A graduate of this program will demonstrate an understanding of diverse physical and chemical phenomena in terms of fundamental concepts and will be able to apply their knowledge of math, chemistry, and physics to identify, formulate, and solve problems in the fundamental disciplines of organic, inorganic, analytical, physical, and bio- chemistry.

b. Assessment techniques/measures: (How do you assess student learning to know if your majors are achieving the desired outcomes?)

Our primary assessment instruments include standard ACS examinations given at the conclusion of the introductory (General and Organic Chemistry) courses and the GRE Chemistry Achievement test to evaluate the objectives under Goal number 1. Due to the expense of this test, we have been considering a switch to the ETS Major Field Achievement Test (MFAT), which has the advantages of being nationally normed, controlled and designed by others outside PSU, and relatively inexpensive. This test will also give a breakdown by sub-discipline, which will be helpful in identifying weak areas. We also continue to survey our alumni as part of our annual newsletter. Fewer than 1% respond, but occasionally we get interesting responses. More than one has commented that they enjoyed the free soft drinks and cookies that were offered with the required colloquium.

c. Document student achievement: (Provide assessment data by outcome.)

Gen. Chem. I	SPRIN 2001	FALL 2001	SPRING 2002	SPRING 2003		SPRING 2005		FALL 2006
# students	64	56	81	35		36		48
average	31.5	36.9	32.7	30.3	38		31.2	
ACS exam	1997	2002	2002	1997	2002	2005		
Median score from ACS	39.5	41.2	41.2	39.5	41.2	NA		

Organic Chemistry: ACS average (70 questions):	2004	2005	2006
National Median: 35	26	23	24

Employment or Graduate School following the B.S.: 100%

Conclusion: Mean test scores on standard ACS exams are consistently below national median scores but within one standard deviation. This is consistent with the fact that the average ACT score of Chemistry majors at PSU (25.2) is slightly below the national average ACT score for Chemistry majors (26.5). However, scores in Organic Chemistry appear to be lagging more than those in General Chemistry. In part, this may be due to the fact that enrollment in this service course subject, and therefore the test average, is dominated by students who are Biology majors, many not even minoring in Chemistry, who have lower ACT averages on entering the course.

For many years, we have also been convinced that the lag is a result of the focus of the ACS test design than with our program, especially since our Pre-Med majors do very well on the MCAT examination, last year averaging 30.5, two as high as 37, when the minimum for entry at KU, for example, was 27. Chemistry majors in Pre-Med also were accepted to some of the best medical schools, last year including Johns Hopkins, Harvard, Case Western, and Baylor. Last year we even had one student accepted for the very selective and prestigious Medical Science and Technology Program (MSTP), which is a joint M.D. and Ph.D. degree program that admits only about 300 students nationwide. Six Chemistry majors have also been accepted at very competitive REU programs at Harvard, Johns Hopkins, Vanderbilt, Washington University, and IBM-Almaden.

We have concluded that we need a more detailed and targeted assessment instrument, one that is applied at the end of the program rather than just at milestones within it. Ideally this should be an instrument which can also be taken by our M.S. students to directly demonstrate value added in the graduate program. Such an instrument also needs to include Biochemistry.

d. Changes based on assessment: (Demonstrate that assessment data is used to improve student learning and effectiveness of the program.)

The Department has decided to add the MFAT in Chemistry to the Senior Colloquium requirements. We have ordered this test from ETS but do not yet have scores to report. This test will give individual scores on the following components: Physical Chemistry (thermodynamics, kinetics, quantum chemistry), Organic Chemistry (molecular structure, functional groups, reaction mechanisms, biochemistry, and various special topics), Inorganic Chemistry (general, periodic, bonding, metallic and ionic, main group elements, transition elements, and special topics) , Analytical Chemistry (experimental design, homogeneous and heterogeneous equilibria, solutions, instrumental methods, and critical thinking).

The ACS is also developing a capstone test called the DUCK (Diagnostic of Undergraduate Chemistry Knowledge), which

we are also considering using in addition to the MFAT. This will allow a breakdown of scores in the following areas: Atomic Theory and Structure, Chemical Bonding, Molecular Structure and Structure Determination), Intermolecular Forces and Properties, Chemical Reactions and Synthesis, Thermodynamics and Thermochemistry, Reaction Kinetics and Mechanisms, Chemical Equilibrium, Experiments, Safety and Data Handling.

The advantage of the MFAT test is that it will give us averages before and after the M.S. degree and is very widely used by other institutions, thus enabling national comparisons. The DUCK may eventually be as popular, and it has the sanction and expertise of the ACS, which is responsible for the other undergraduate tests we use.

Prior to about four years ago, the average MCAT score among our Pre-Med majors was just above the entry minimum, of 27. In an effort to improve acceptance into medical schools, we rather selectively put Pre-Med majors in charge of our tutorial services for the introductory courses, the topics that were the focus of about half of the MCAT questions. The result has been the dramatic jump in MCAT scores from 27-28 to 30.5 . This highlights the need for an intensive review immediately prior to standardized testing. Clearly, students would not be able to perform in the tutorial capacity without adequate preparation in the classes, but such tutoring insures that the material is fresh and easily remembered during testing. Thus, we have started such a review of this material in our Chemistry Colloquium, and will schedule it to complete immediately prior to having students take the MFAT examination.

All of the experiments in our Organic labs have been restructured, at least in part in response to the low ACS scores in those classes. These labs had last been revised around 1999, when the inquiry approach had been adopted and experiments were "greened" by switching from expensive and hazardous chemicals to extractions from spices and other materials available from the grocery. However, the reduced structure did not seem to be effective or comfortable for our students, so the experiments and their lesson plans were returned to a more directed format last year. We hope this will eventually result in improvements in the organic scores, although we continue to question the validity of the standardized ACS exam. Many other institutions have stopped using it for just this reason. We hope the new MFAT assessment will provide more detailed and reliable information on course effectiveness.

Both professors who have taught the Organic labs (Pavlis and Hamlet) will be leaving at the end of the current academic year, so the program will very likely be redesigned yet again this Fall with newly hired faculty.

Course content and instrumentation for the introductory labs have been modified based on student survey results. These included support for proposals for Student Fee allocations to new equipment specifically for these labs.

Also, safety and compliance issues merited increased attention after a non-notice inspection by the KDHE three years ago. Their feedback prompted a revision of our hazardous waste storage and disposal procedures, including better record keeping and vigorous internal inspections.

10. Continuous Improvement – Program Plan

a. Program strengths, weaknesses, opportunities, and threats analysis:

Due to a combination of outside grants and university investments, this department is now among the best equipped for a school of this size in the nation. The centerpiece is the Bruker solid state NMR system, which is now on line and contributing to training advanced students, faculty research, and community support. In one of the best equipped programs in the nation in surface chemistry, we routinely carry out very low temperature ultra high vacuum (UHV) experiments using highly sensitive in situ FT-IR and mass spectroscopy. For the last few years, a research grant from the Office of Naval Research has sponsored research on nano-particle composites and catalysts and has supported undergraduates in summer research.

We also have a state of the art biochemistry research facility with equipment to support modern recombinant DNA research, characteristic of Ph.D. granting institutions, including Polymerase Chain Reaction (PCR) (Perkin Elmer PCR thermal cycler), DNA cloning and site directed mutagenesis, DNA sequencing with two vertical gel electrophoresis chambers, Polyacrylamide and Agarose gel electrophoresis equipment, Fluorescence Spectroscopy, Spex Fluoromax-2 Spectrofluorometer. PSU is the only institution of our size in Kansas to have a steady state spectrofluorometer. Only KU has another one in Kansas. The restructuring of the biochemistry courses based on these capabilities and ACS certification requirements has increased activity among students interested in this field, and increased involvement with biology majors.

Our computer lab adjacent to the introductory chemistry laboratory has been expanded to a 16-station computer facility, which provides real time data reduction during class meetings and internet access, high speed laser printing, and general PC applications outside of classes. Advanced computational capability for large scale molecular modeling has been address with a 16 node Beowulf system.

The new data bases of journal abstracts and 35 on-line journal subscriptions at the Axe Library have turned what the ACS certification committee had considered a weakness, lack of journal availability, into a strength.

Finally, safe storage of chemicals has been improved with reorganization of the storage building.

b. Program changes currently being considered and those likely to be implemented within the next five years:

We plan to add automated inventory management software and labeling of stored chemicals under a site license through BTI.

Degree Program Review

1. Program Identifiers

College:	Arts and Sciences				
Department:	Chemistry				
Degree Program:	**PSU Degree Code**	**CIP Code**	**Degree**	**Program Name**	**Options**
	DG	**400501**	**Bachelor of Science in Education**	**Chemistry**	**No Emphasis**

2. Faculty That Support Program

Pavlis, Hamlet, Siam, Shirley, Paul, McAfee, Zegar

3. Number of Majors

	FY/02	FY/03	FY/04	FY/05	FY/06
Lower Division	6	1	4	1	1
Upper Division	1	0	2	3	3
Graduate					
Total	7	1	6	4	4

4. ACT scores of majors

	FY/02	FY/03	FY/04	FY/05	FY/06
Ave ACT Score	NA	NA	27	25	24.7

5. Degrees Awarded

	FY/02	FY/03	FY/04	FY/05	FY/06
	1	0	0	0	0

6. Program Changes Since Last Review

None. The BSEd is essentially the same as the Option II BS above, so there were no changes. BSEd in Chemistry majors are essentially the same as Option II majors. They take the same courses and are evaluated and assessed exactly the same. Consequently, all of the information that follows for this degree is essentially the same as for Option II above, except for questions specific to teachers. It really should have been combined with Option II, as it has been in past reviews.

7. Program Foundations

a. Program description:

The BSEd in Chemistry prepares graduates as teachers for secondary education in the sciences, particularly in chemistry, physical science, or physics. Course offerings provide a competitive knowledge base and basic problem solving skills in inorganic, organic, physical, analytical, and bio- chemistry, while promoting excellence in critical thinking, communication, and good citizenship.

b. Accreditation status – if any: (If not accredited explain why.)

Since this is technically a specialty of the College of Education's BSEd major, it is accredited under the general umbrella of NCATE.

c. Program goals and objectives:

The BSEd in Chemistry prepares students, in both theoretical and practical laboratory experience, for employment as teachers at the secondary level in chemistry. It is designed to produce graduates who …

GOAL 1: … understand the theoretical and mathematical basis of our current understanding of chemical processes in organic, inorganic, physical, and bio- chemistry.
Objective 1: Accurately and rigorously apply fundamental mathematical principles and notation, including algebra and differential and integral calculus.
Objective 2: Demonstrate principles and solve fundamental problems in inorganic chemistry, including atomic structure, periodic properties, molecular bonding, reactions, and gases.
Objective 3: Demonstrate principles and solve fundamental problems in kinetics, equilibrium, acids, bases, and thermodynamics.
Objective 4: Demonstrate principles and solve fundamental problems in organic chemistry, including bonding, structure, nomenclature, mechanisms, and reactions.
Objective 5: Demonstrate principles and solve fundamental problems in analytical chemistry, including gravimetric, volumetric, spectroscopic, chromatographic, and electrochemical analyses.

GOAL 2: …are able to use scientific instrumentation and safe laboratory procedures to design, conduct, and interpret basic scientific experiments.
Objective 6: Find and interpret relevant research and current theoretical understanding needed to plan, conduct, and interpret basic experiments in the physical sciences.
Objective 7: Formulate a testable scientific hypothesis.
Objective 8: Select and safely configure laboratory instrumentation to generate data relevant to a scientific hypothesis.
Objective 9: Use computers and appropriate software or programming language to analyze, reduce, and graphically present experimental data.
Objective 10: Based on a proper analysis of experimental data, draw an appropriate scientific conclusion.

GOAL 3: … are able to communication scientific ideas and information effectively using modern digital technology.
Objective 11: Organize and present scientific information in a written report using appropriate notation, format, and citations.
Objective 12: Organize and present technical information to a live audience using presentation software and effective speaking techniques.
Objective 13: Use technology to communicate informally with others in the field, for example, using email and web pages.

8. Curriculum

a. National/professional guidelines: (How does the curriculum align with national/professional guidelines?)

The Kansas Board of Education has revised its science standards to again conform to the National Research Council's "National Science Education Standards" and to the National Science Teachers' Association's "Pathways to Science Standards." Our program conforms to all of these.

b. Curricular alignment with external constituent needs:

The primary external constituent for these two programs is the Kansas Board of Education, to whose standards we adjust to maintain alignment.

c. Course sequencing: (Show the sequence of courses students should follow to graduate in 4-years.)

Year 1: Calculus I , General Chemistry I
General Chemistry II, Engineering Physics I

Year 2: Engineering Physics II, Programming
Organic I, Analytical
Year 3: Organic II, Biochemistry I
Physical Chemistry I
Year 4: Electives
Electives, Senior Colloquium

d. Program delivery methods:

Introductory courses include both a lecture component for theory and mathematics plus a laboratory component in which hands on practice is used to illustrate chemical principles and provide familiarity with measurement techniques and modern equipment. Upper level elective options also include projects and guided research classes, in which a particular system or approach is expanded to fill an entire semester. Lecture classes primarily focus on solving drill problems, both in class and as homework assignments, with examinations to test the skills and knowledge developed. Some classes also include research projects in for which students read literature and use library resources to generate a written report. The laboratory classes focus on working with standard laboratory devices and instruments to perform experiments, analyze data, quantify measurement errors, draw justified conclusions, and prepare a written report.

9. Assessment of Student Learning: (From annual assessment report.)

a. Specific desired student outcomes: (What specific knowledge, skills, and experiences should a graduate of this program possess?)

A graduate of this program will demonstrate an understanding of diverse physical and chemical phenomena in terms of fundamental concepts and will be able to apply their knowledge of math, chemistry, and physics to identify, formulate, and solve problems in the fundamental disciplines of organic, inorganic, analytical, physical, and bio- chemistry.

b. Assessment techniques/measures: (How do you assess student learning to know if your majors are achieving the desired outcomes?)

Our primary assessment instruments include standard ACS examinations given at the conclusion of the introductory courses and the GRE Chemistry Achievement test to evaluate the objectives under Goal number 1. Due to the expense of this test, we have been considering a switch to the ETS Major Field Achievement Test (MFAT), which has the advantages of being nationally normed, controlled and designed by others outside PSU, and relatively inexpensive. This test will also give a breakdown by sub-discipline, which will be helpful in identifying weak areas. Education majors must also take the Praxis test in the PPST examination for entry into the program.

c. Document student achievement: (Provide assessment data by outcome.)

Results in the ACS standardized examinations are incorporated into the representative sampling presented under the B.S. degree. The following are the results of the Praxis tests given to all Ed. majors in Chemistry.

Year	Major/Degree	Chemistry (152)
FA03-SP04		
D.L.	Biology/B.S. Ed	107.00
FA04- SP05		
M.B.	Physical Science/B.S. Ed	114.00
A.E.	Liscensure only	129.00
M.S.	Biology/B.S. Ed	160.00
M.S.	Chemistry/B.S. Ed	174.00
S.Y.	Chemistry/B.S. Ed	132.00
FA05-SP06		
A.M.	Physical Science/B.S.Ed	148.00
Recent		
P.B.	Liscensure only	153.00
Average		139.63
Passed		3/8 (none rejected)

d. Changes based on assessment: (Demonstrate that assessment data is used to improve student learning and effectiveness of the program.)

As with the Physics Praxis test, Chemistry and Physics majors tended to do better on their own tests than majors in Physical Science or Biology. These content tests at least partly demonstrate the confusion produced by changing standards for teachers, and particularly the problems that result from standards being disconnected from the required standardized tests. Since the BSEd in Chemistry is essentially the same program as the Option II B.S. in Chemistry discussed above, the same changes apply.

The Department has decided to add the MFAT in Chemistry to Senior Colloquium requirements, but do not yet have scores to report. We may also adopt the ACS capstone test called the DUCK (Diagnostic of Undergraduate Chemistry Knowledge). Both of these will allow a breakdown of scores by subject areas. Course content and instrumentation for the introductory labs have been modified based on student survey results. These included support for proposals for Student Fee allocations to new equipment specifically for these labs.

Also, safety and compliance issues merited increased attention after a non-notice inspection by the KDHE three years ago. Their feedback prompted a revision of our hazardous waste storage and disposal procedures, including better record keeping and vigorous internal inspections.

10. Continuous Improvement – Program Plan

a. Program strengths, weaknesses, opportunities, and threats analysis:

This BSEd degree mostly piggy backs on the Option II program. It does not require any other resources or courses, so the low enrollment really only reflects the continuing problem in Kansas of not training enough teachers in the sciences and having teaching performed by those without qualifications. Again, this major would be better listed with the BS Option II, since these have the same goals, tests, and other documentation.

b. Program changes currently being considered and those likely to be implemented within the next five years:

None anticipated, except to complete the implementation of efforts in our senior colloquium to help BSEd majors to pass their Praxis exams. We may also require a capstone course for reviewing this material and taking the other tests.

Degree Program Review

1. Program Identifiers

College:	Arts and Sciences				
Department:	Chemistry				
Degree Program:	**PSU Degree Code**	**CIP Code**	**Degree**	**Program Name**	**Options**
	DG	**400501**	**Master of Science**	**Chemistry**	**No Emphasis**

2. Faculty That Support Program

Pavlis, Siam, Hamlet, Shirley, Paul, McAfee, Zegar, Petrovic*, Javni*, Guo*, Hong*
***BTI-KPRC graduate faculty**

3. Number of Majors

	FY/02	FY/03	FY/04	FY/05	FY/06
Lower Division					
Upper Division					
Graduate	6	7	7	7	10
Total	6	6	7	7	10

4. ACT scores of majors

	FY/02	FY/03	FY/04	FY/05	FY/06
Ave ACT Score	NA	NA	NA	NA	NA

5. Degrees Awarded

	FY/02	FY/03	FY/04	FY/05	FY/06
	5	1	3	2	4

6. Program Changes Since Last Review

None.

7. Program Foundations

a. Program description:

The M.S. program in chemistry trains chemists for superior career positions in either chemical laboratory, medical, chemical education, or industrial settings requiring advanced technical problem solving, such as process development, forensic analysis, diagnostics, environmental protection, or collaborative efforts with chemical engineers, physicians, or other scientific researchers. Course offerings provide an advanced knowledge base and problem solving skills in organic, polymer, inorganic, physical, analytical, or bio- chemistry, while promoting excellence in critical thinking, communication, and good citizenship. A combination of upper level electives and independent research allow candidates to shape a field of specialization within chemistry. Graduates make valuable contributions to appropriate professional organizations, to the body of scientific knowledge, and to the betterment of humanity.

b. Accreditation status – if any: (If not accredited explain why.)

Not accredited. No appropriate agency.

c. Program goals and objectives:

The M.S. in Chemistry is designed to produce graduates who …

GOAL 1: … understand advanced theoretical and mathematical bases for chemical phenomena.
Objective 1: Accurately and rigorously apply advanced mathematical principles and notation of mathematical and computational chemistry.
Objective 2: Demonstrate principles and solve advanced problems in physical chemistry.
Objective 3: Demonstrate principles and solve advanced problems in at least two other sub-disciplines of chemistry, including analytical, biological, computational, inorganic, or organic chemistry.
Objective 4: Know how to comply with local, state, and federal regulations governing hazardous materials and safety.

GOAL 2: …are able to use scientific instrumentation and safe laboratory procedures to conduct independent research.
Objective 5: Find and interpret relevant research and current theoretical understanding needed to plan, conduct, and interpret advanced experiments.
Objective 6: Use computers and appropriate software or programming language to analyze, reduce, and graphically present experimental data.
Objective 7: Based on a proper analysis of experimental data, draw an appropriate scientific conclusion appropriate for publication.

GOAL 3: … are able to communication scientific ideas and information effectively using modern digital technology.
Objective 8: Organize and present scientific information in a written thesis or report using appropriate notation, format, and citations.
Objective 9: Organize and present technical information in a thesis defense using presentation software and effective speaking techniques.
Objective 10: Use technology to communicate informally with others in the field, for example, using email and web pages.

8. Curriculum

a. National/professional guidelines: (How does the curriculum align with national/professional guidelines?)

In many Ph.D. Chemistry programs, the M.S. degree is only awarded to students preparing to take the Ph.D. but unable to pass a rigorous candidacy examination. As a result, the standard definition for these institutions is very close to qualifying for the independent research of a Ph.D. thesis, and they use the same guidelines expected for a Ph.D. Offering the M.S. as a terminal degree, we require very much the same course work for this standard, but do not require the level of preparation needed for a candidacy examination.

b. Curricular alignment with external constituent needs:

As a result, our students often view the M.S. as further preparation for the GRE examination and further graduate progression toward the Ph.D. or an advanced Chemical Engineering degree. We tend to count the program as quite successful if GRE scores are improved and our graduates are accepted for further graduate training. However, we also have some M.S. graduates who go directly into employment in industry, so we really consider both types of guidelines in planning curriculum.

c. Course sequencing: (Show the sequence of courses students should follow to graduate in 4-years.)

The M.S. can be completed in 18 months, not four years. Students take one course in Physical Chemistry, two three-hour courses from the list of other sub-disciplines, six hours of independent research, and other electives totaling 31 hours for the thesis. We also list a research problem option requiring 33 hours, but students are strongly encouraged to complete the thesis unless there are special circumstances that prevent it. This is one of the strengths of the M.S. program, that essentially all graduates complete a thesis.

d. Program delivery methods:

Same as for the undergraduate degrees.

9. Assessment of Student Learning: (From annual assessment report.)

a. Specific desired student outcomes: (What specific knowledge, skills, and experiences should a graduate of this program possess?)

Same as for the B.S. in Chemistry but at the graduate level, i.e. solve problems in three specified areas, perform independent laboratory research, and report it effectively in written and verbal forms.

b. Assessment techniques/measures: (How do you assess student learning to know if your majors are achieving the desired outcomes?)

Goal 1 has been assessed by an ACS standard examination administered during our Comprehensive Reviews class and by the GRE examination, which was to be completed prior to graduation. However, this latter requirement was dropped by the Graduate Council, and none of our recent graduating M.S. students have opted to take the examination, even though the Department has a standing offer to pay for it. Consequently, we have switched to the MFAT test for both B.S. and M.S. candidates. By using the same test for each, this should help us assess the "value added" of the M.S. program. Goals 2 and 3 are still assessed by the committee that reviews their thesis and its defense. We also survey our alumni as part of our annual newsletter. Fewer than 1% respond.

c. Document student achievement: (Provide assessment data by outcome.)

Comprehensive Review Test			Percentile	
Scores for ACS exams by year:	2006	Organic	43/70	66
			23/50	%not avail. (2006 Thermo test)
			53/70	76
			25/40	96
			16/40	57
			15/40	49
	2005		17/40	65
			17/40	65
			19/40	78
			28/40	98
	2004		18/40	72
			18/40	72
			29/40	99
			16/40	57
	2003		20/24	83
	2002		20/40	83
	2001		50/70	82
			17/40	65

100% of graduates contacted are either employed or in a further graduate program. Of our last 15 MS graduates, 6 are working on their Ph.D. in major universities, 2 are in medical school, 5 are known to be employed as chemists in industry or teaching, with 2 unknown.

d. Changes based on assessment: (Demonstrate that assessment data is used to improve student learning and effectiveness of the program.)

Due to low scores and classroom performance by students transferring from a Pharmacy program in India, we no longer accept such students, although they appear on paper to have met all the coursework requirements. There is an obvious strong correlation between scores on the tests used for Comprehensive Reviews and grades in the corresponding classes, particularly if the student is asked to take remedial undergraduate courses or prerequisites. Consequently, we are confident in the normal grading procedures of lectures and labs to identify students that need extra help.

An older change based on assessment was the decision to ask all M.S. students to complete a thesis. This commitment was made before the current review period, but it has continued to produce more employable and better experienced graduates.

10. Continuous Improvement – Program Plan

a. Program strengths, weaknesses, opportunities, and threats analysis:

We continue to address student feedback about modern equipment. As mentioned under the B.S. program, outside grants and university investments have placed this department among the best equipped for a school of this size in the nation. With the Bruker solid state NMR system, the low temperature ultra high vacuum (UHV) surface chemistry system for studying nano-particle composites and catalysts, biochemistry equipment for recombinant DNA research, and other analytical instruments, we give students valuable experience in modern chemical research methods. However, there is a continuing need for research grade equipment associated with particular faculty research or for travel funding to take students to facilities at other locations. With a new organic chemist coming this Fall, we will be providing some start up funds for his research instrumentation, but this will be difficult, since the cost of modern research instruments is an order of magnitude or greater than the resources available locally. Consequently, if we are ever to acquire such equipment, funding must come from a grant from an outside funding agency, hence another motivation for our emphasis on grant proposal submissions.

The world class polymer chemistry lab at the Kansas Polymer Research Center at BTI is a major resource for student research, particularly at the M.S. level. We send many of our students to this program for their thesis research and for financial support. The expert personnel there, listed above as supporting faculty, contribute to thesis advisement and as collaborators on research publications. Their advanced instrumentation and facilities, soon to move to a new building, are a major boon to our programs, allowing students access to equipment that is completely unavailable at comparable institutions.

Dr. Ratzlaff's experiment in increasing funding to GTAs in Physics has evidently been quite successful in recruiting M.S. students to the Physics programs, but it raised the ire of other graduate students, particularly those in Chemistry, who did not receive a similarly increased stipend. The current allotment of 3 GTA positions per year is nearly sufficient to provide assistance in all the lab classes for which these students would be qualified, but it supports less than 1/3 of our graduate enrollment in Chemistry. A larger fraction of our M.S. students are supported by Research Assistantships at KPRC and in the College of Technology (ONR grant), both of which pay more than the basic GTA stipend. The inequity between the GTA stipends in Physics and Chemistry needs to be addressed.

b. Program changes currently being considered and those likely to be implemented within the next five years:

A new organic chemist will join the faculty this coming Fall, replacing Robert Pavlis, who will be retiring. This will create an opportunity to reevaluate the structure of our organic and polymer chemistry classes and the associated labs. Also, Dr. Peter Hamlet has very recently decided to retire early for personal reasons, which will give us a further opportunity to restructure the composition of the faculty. Although we would like to expand expertise in the area of polymer chemistry, to enhance that aspect of our program and further support the KPRC, the cost is probably prohibitive. Consequently, the most likely direction is to simply replace both faculty with organic chemists.

The ACS is just completing an evaluation of the certified B.S. degree program, which may also prompt parallel changes at the graduate level. We plan to continue to seek additional outside funding for student research and much needed equipment. Individual lab courses continue to be upgraded to include the most relevant and current experiments.