**Academic Program Review: Self-Study**

***Instructions:*** *The following pages will guide your submission of your academic program review self-study. Please type your responses directly into the document. The completed self-study instrument and all attachments must be submitted to the Academic Program Review Coordinator and your Academic Dean by September 1.*

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| **Program Under Review** |
| Degree(s): Associate of Science in Chemistry |
| Certificate(s): N/A |
| Contact Information for lead on Self-Study: Name: Bruce MartinCampus: SMCPhone: x7715Email: bruce.martin@centralaz.edu |

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| **Program Description, Vision and Outcomes** |
| What is the description of the program as stated in the current CAC catalog:The Chemistry A.S. Degree is appropriate for students who plan to transfer to the university to earn a baccalaureate degree in physical science areas such as Chemistry and related pre-professional programs. It is also appropriate for students interested in becoming lab technicians. |
| Does your program have any other written mission or vision statements which do not appear in the catalog? If yes, please write them below and indicate where they appear. N/A |
| Describe how the program’s description, mission and/or vision aligns with the College’s Mission:This degree allows the interested students to be on track for their transfer to desired four-year programs, per the college’s mission, which includes not only chemistry but also for chemical engineering and various other engineering-related programs. Our program is also helpful for students pursuing the college mission aspects of job training for occasional chemical technician jobs.  |
| What are the student learning outcomes for the degree or certificate as currently indicated in ACRES:1. (Application Level) Using the principles of stoichiometry, accurately complete and balance chemical equations. 2. (Application Level) Using molarity, accurately calculate concentrations, titrations and dilution amounts. 3. (Analysis Level) Using concepts of specific heat capacity, enthalpy and calorimetry, accurately analyze and calculate energy changes in physical and chemical reactions. 4. (Application Level) Using the main-group valence electron theory and the octet rule, accurately predict electronic and molecular geometries of molecules, their polarity, their valence-bond hybridization. 5. (Analysis Level) Using molecular geometry, accurately predict relative intermolecular forces and boiling points. 6. (Analysis Level) Analyze concentration data to calculate reaction rates. 7. (Analysis Level) Analyze buffer concentrations to calculate titration curves for strong or weak acids. 8. (Application Level) Calculate concentrations of soluble species in reactions. 9. (Application Level) Calculate quantities in electrochemistry reactions. 10. (Application Level) Calculate rates of radioactive decay and radiochemical dating. 11. (Analysis Level) Identify functional groups of organic molecules. 12. (Application Level) Predict the reaction pathways of substitution and elimination. 13. (Synthesis Level) Predict major products for organic reactions. 14. (Analysis Level) Identify the monomers that make up basic polymers. 15. (Analysis Levels) Demonstrate the proper techniques for using scientific lab equipment properly and safely to perform a variety of chemical procedures and techniques, such as to obtain chemical data, measure and dispense reagents. Actively and successfully complete safely the assigned series of laboratory experiments (in a supervised instructional laboratory) or field trips in which observation and critical reasoning skills are employed in the development of detailed report writing, within the allotted time. 16. (Synthesis Level) Actively and successfully develop and write detailed reports on the assigned series of laboratory experiments or field trips while demonstrating observation and critical reasoning skills.  |
| Are the outcomes from your program determined or influenced by any external organization, agency, or accreditor? If so, please explain.This degree is in accordance with the American Chemical Society's (ACS) Guidelines for Chemistry in Two-Year College Programs, published by the American Chemical Society Committee on Education.For example, the ACS recommends that institutions should schedule classes so that students can complete both general and organic chemistry sequences in two academic years, and that courses should be coordinated with the schedules of the other required courses in the common degree tracks. This was actually one of the reasons for creating the A.S. in Chemistry degree program.In another example, the ACS recommends that lecture and lab components of courses are taken concurrently. We have set up our courses such that this always happens for our main courses of CHM130, CHM151, CHM152, CHM235, and CHM236. We are in the process of also working to implement this for the specialty course CHM138, and anticipate completion of this by fall of 2016. |

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| **Program Enrollment and Graduation Trends** |
| Summarize the program enrollment data for the past 5 years in the chart below: (from Fact Book)This data has been requested from Institutional Research, and it is not yet available. We are told by their office that it will be available soon.

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| --- | --- | --- | --- | --- | --- |
| Degree/Certificate | 2014-15 | 2013-14 | 2012-13 | 2011-12 | 2010-11 |
| A.S. - Chemistry | (see note above) | (see note above) | 0 | 0 | 0 |
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| Discuss and explain the factors influencing the enrollment trends:Overall, this is a new program, and thus the college has not yet obtained enough data to enable any meaningful analysis.The College’s MAP form for A. S. in chemistry degrees had become unavailable to the college. We succeeded in getting a replacement created and distributed in Spring of 2015. Further, the college’s standard class registration form did not allow the specification of designated A.S. degree specializations (such as agriculture or chemistry) until we were able to get that created in Summer of 2015. In addition, the standard college graduation form has not allowed any students to specify their pursuit of this A.S. degree. We enabled two students to specify this to the college this Spring 2015, despite the absence of an enabling form.We expect a growing number of students to graduate with this degree in future years, now that student access is starting to be enabled by the college. |
| How has the program typically recruited students and marketed the program:(1) The catalog. (2) Advising. (3) Professors and STEM staff speaking to classes and giving handouts including discussions of related career opportunities in our fields. (4) STEM nights at the College.We have also tried to envision enhanced recruitment strategies for the college to adopt if interested.We have been hindered by the inability to connect students directly with successful chemistry graduates now in industrial or scientific careers, using Skype or other web-based technologies in our classroom, due to the hard-wired internet bandwidth connectivity limitations of our classroom in the T-building at SPC. Note that this is a college-wide issue, because the bandwidth is sufficient outside of normal working hours. But during normal business hours, when the classrooms are competing with other college activities, the bandwidth has been insufficient to sustain a reasonable Skype connection, as of Spring 2015. |
| Summarize the program graduation rate trends for the past 5 years in the chart below: (from Fact Book)This is an increasing trend in a sense, because this is a new program.

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| --- | --- | --- | --- | --- | --- |
| Degree/Certificate | 2014-15 | 2013-14 | 2012-13 | 2011-12 | 2010-11 |
| A.S. - Chemistry | 2  | 1 | 0 | 0 | 0 |
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| Discuss and explain the graduation trends. What efforts has the program made to help students achieve completion?We try to empower our students to sign up to graduate in their desired specific degree program and career pathways. This is successful if the students are willing to get properly MAPped by a science or STEM advisor. We also work to provide our students with useful advising, to help them enroll in the courses they need. In the past, STEM has also provided Supplemental Instruction to support our CHM130 and CHM151 classes (the two largest courses). |

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| **Program Curriculum:** *Submit a completed Curriculum Comparison Chart along with the self-study, comparing the CAC program curriculum to three similar programs, for each Degree and Certificate discussed in this self-study. Ideally compare to other Arizona programs, and out of state if necessary.* |
| Using information gained from your curriculum comparisons, discuss the strengths and weaknesses of the current program curriculum for each degree or certificate. The Chemistry program suffers from the enrollment weakness that transfer-oriented science students should be looking to take University Physics along with CHM151 and CHM152. Unfortunately, none of the College’s campuses other than the SPC campus offer a proper physics sequence, due to low enrollment at those locations. Thus, well-informed students at the other campuses may decide to attend competing college districts entirely, so as to obtain both university chemistry and university physics at the same location. This is hard to measure, but likely inhibits chemistry enrollment at all of our other campuses.The Chemistry program has been as good as any other community college program in Arizona, in that it offers the same courses everyone else transfers. However, to further help our students, we are revising our program to add more Active Learning activities and aspects to our labs and coursework. |
| Discuss how the program gets feedback on its program and curriculum from external sources, suchas advisory boards, employers, articulation task forces, accreditors, etc.We hear the most relevant information mainly from the Chemistry Articulation Task Force committee members. We also hear informally from several past graduates and from community members involved in these employment areas.Further, we try to continuously monitor the specific program and degree requirements of the four-year degree programs to which our students commonly transfer. |
| Indicate any external accreditations which the program has. Are there any available accreditations which the program does not have, but maybenefit from seeking?N/A |
| Discuss how the program supports current or future needs for the job market in Pinal County, the state of Arizona, and/or the United States.The program is oriented for students transferring to get a baccalaureate or higher degree, so usually not for directly getting a rare technician job. Our students will be filling the future Arizona and national job areas in chemistry, chemical engineering, material science, semiconductor fabrication, polymer chemistry, petroleum engineering, and related fields. There are general national trends indicating a likely increase in careers involving a technical background that relates to chemistry.While national job openings from 2012-2022 are said by BLS.gov to be 28,000 for pure chemists, the national job openings will be 221,500 over that period when we include the many other chemistry-related careers for which the A.S. in Chemistry could be an appropriate beginning.When we add in the anticipated 21,600 job openings for chemistry technicians with a terminal A.S. degree, the total is 243,100 job openings through 2022, following this degree program pathway.Some of the related careers for chemists include: various engineers (biomedical, chemical, materials, geological, nuclear, and petroleum), along with biochemists, zoologists and other biological scientists, epidemiologists and other medical and life scientists, environmental and other physical scientists, and chemistry and environmental science post-secondary teachers. |
| For degree programs, identify any specific in-state baccalaureate programs into which this program is particularly suited for transfer: The program is suitable for all four-year universities, especially for those in Arizona (which use the AGEC-S) and nationally (and internationally). This includes a B.S. or B.A. in chemistry, or a B.S. in chemical engineering, material science, or polymer chemistry,  |
| Indicate any articulation agreements in place for degree graduates.Arizona State University – B.A. in Chemistry; BAE-Secondary Education (Chemistry)Grand Canyon University - BS-Secondary Education (Emphasis in Chemistry) |

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| **Program Specific Resources:***In this section please focus on program specific resource. You may but do not have to discuss resources available to the college at large such as Blackboard, the Learning Centers, Library, etc. However, if these resources are impacting your program in a positive or negative way which you would like to discuss, please do so.* |
| Discuss the adequacy of the financial and budgetary resources available to the program over the past 5 years:We need several chemical instruments, such as an FTIR spectrometer, many of which will be significant capital purchases. The STEM grant has provided small instruments and other resources over the past 5 years. When the college opened up the San Tan Campus, it was unable to provide a budget for proper setup and stocking of this campus. This campus alone took out over $34,000 out of our normal operating budget for physical sciences, which is not standard operating behavior. Ideally, each campus for which we are serious about offering chemistry should have their own FTIR spectrometer, melting point apparatus, and so on. |
| Discuss the adequacy of the human resources available to the program over the past 5 years:We have just acquired one new full-time chemistry professor, in order to serve the two new campuses over which our program now extends.We are grateful for the funding for our vitally necessary lab technicians to support our classes. Of course, it has been a challenge to obtain and retain high-quality staff in some cases. At this moment, we are now in a relatively good situation at the SPC and SMC locations, but more at all locations would be helpful.Through much of the STEM program, we were temporarily able to get a STEM advisor to help students in our program and other related programs. We have established that our program success is highly dependent upon proper and fully informed advising, which is in turn most feasible only with advising from science faculty or from such a dedicated STEM advisor. We hope that when the STEM grant expires, that the college will take on the burden of maintaining funding for a dedicated STEM advisor to serve the needs of the many Central students who are now benefitting from our program and related ones.The recruiting and “MAPping” services provided by these specialized advisors is so critical to our program that we can be assured that the college’s A.S. in Chemistry degree program will significantly decline if such staffing becomes unavailable. |
| Discuss the adequacy of the technological resources available to the program over the past 5 years:Lack of adequate internet accessibility at SPC (in building T, etc.). This prevents connection with outside speakers who are involved in real-world job activities.We have been hindered by the inability to connect students directly with successful chemistry graduates now in industrial or scientific careers, using Skype or other web-based technologies in our classroom, due to the hard-wired internet bandwidth connectivity limitations of our classroom in the T-building at SPC. Note that this is a college-wide issue, because the bandwidth is sufficient outside of normal working hours. But during normal business hours, when the classrooms are competing with other college activities, the bandwidth has been insufficient to sustain a reasonable Skype connection, as of Spring 2015. |
| Discuss the adequacy of the physical (building space, classrooms, labs, etc.) resources available to the program over the past 5 years:The classrooms lack the internet router capacity to service events when all students have an internet-enabled device (e.g., iPad for instrumentation).We must also obtain upgraded electrical wiring service (in classroom SPC T-209), to enable a hotplate or magnetic stirrer to be in use by each student team. The initial room renovation contract had specified this level of service, but the contractors neglected to provide this, even when reminded by the college repeatedly. We have recently resubmitted a work order to enable this capability.In the past five years, we have two beautiful new campuses with science labs (STC and MAR), and a new science building at SMC. Unfortunately, all the science classrooms at SMC have intolerable and anti-ergonomic seating, which causes severe distractions and distress for Central students at this location. |
| Discuss the adequacy of the academic support resources available to the program and its students over the past 5 years:Tutoring support has been good, but our students could always benefit from more tutors available for longer hours, if the tutoring budgets were able to provide this. |
| Discuss the adequacy of the student support resources available to the program and its students over the past 5 years:Due to our temporary STEM grant, our student support resources have been excellent for those of our students who encounter them (especially our STEM advisor position).We have also provided degree tip sheets, science book loans, calculator and iPad loans, for those students participating in our temporary STEM grant program. |

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| **Program Effectiveness** |
| Describe how you measure the success of degree and certificate program graduates in achieving the degree and/or certificate program student learning outcomes. What data have you collected that indicates the level of student success of these outcomes? According to the data, how well have students achieved these outcomes during the past 5 years?Our program is too new to have significant data in this area. The two students who we know graduated in 2015 seem to have been successful. And one student graduated the year before. We interviewed two of the three.Student #1:  Graduated with AS/CHM. Taking classes at ASU in Electrical Engineering. Student feels very prepared and comfortable in the ASU classes.  Student feels CAC well prepared him for the content of his ASU courses. Student thought STEM was helpful.Student#2: Graduated with AS/CHM. Taking classes at Central Washington University for a chemistry degree.  When bachelor’s degree is complete, student will transfer to ASU for a master’s degree in chemical engineering.  Student feels prepared to move on to the  university and enjoyed time at CAC.  Student felt the biggest help of the STEM program was the book and equipment loans.  Student wanted to pass on that he felt Professor Beecroft is an excellent teacher. |
| If you have data which indicates the degree to which students in the program are achieving the college’s Common Student Learning Outcomes please share and explain the data.N/A |
| How many program enrollees or graduates studied at an in-state baccalaureate level institution during the past 5 years? Put the data in the table below. \*This data has been requested from institutional research. As this is a new program, we are starting from zero, of course.

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| --- | --- | --- | --- | --- | --- |
| Degree/Certificate | 2014-15 | 2013-14 | 2012-13 | 2011-12 | 2010-11 |
| Chemistry | \* | \* | 0 | 0 | 0 |
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| If a degree is intended for transfer, or has transfer articulation agreements in place, indicate how the degree program supports students with continuing their education at CAC or other institutions. [See above] Our program helps Central students stay on track to complete both their A.S. degree and to complete their bachelor’s degree program with minimum time and tuition needed. |
| Describe the level of success (via completion rates, GPA, etc.) the program’s prior students have achieved at transfer institutions.N/A – Newly completed A.S. students have not yet had time to complete any transfer program. |
| If a degree or certificate is designed to lead directly into the workforce, describe the success of students in obtaining a job in the field of study upon graduation. Please provide any qualitative or quantitative data you have: N/A – This is not the degree’s designed purpose. |
| If your program serves to prepare a student for external certification or licensure of any kind identify the certification or license and the percentage of program graduates who earn/achieve it. Put data in the table below.\* This table is not applicable (N/A) for this program

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| --- | --- | --- | --- | --- | --- |
| Licensure/Certification | 2014-15 | 2013-14 | 2012-13 | 2011-12 | 2010-11 |
| \* | N/A | N/A | N/A | N/A | N/A |
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| **Program Continuous Quality Improvement** |
| Discuss how the program has used learning outcome assessment results to improve instruction and/or student learning over the past 5 years:We are still working to establish baseline data in this area. |
| Discuss how the program has used operational planning goals to achieve quality improvement over the past 5 years:We have been modifying our chemistry lab procedures to include more critical thinking inducements than previously existed. As this is a new development, time has not yet elapsed to enable significant data to be collected on this. |
| Describe other ways the program has engaged in continuous quality improvement: We are working on some PDSA studies in this area. These include items to increase critical thinking in chemistry, and to use presentation and group-study techniques to increase engagement and student success. |

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| **Program Alignment with Institutional Goals:***Describe how the program has directly or indirectly is helping the College achieve its current strategic goals.*  |
| The A.S. in Chemistry Degree program directly or indirectly supports each of the following College Goals:Ensure broad access to high-quality innovative educational programs, services and training opportunities for Pinal County residentsImprove student retention, persistence, completion and job placementEnsure a safe, sustainable environment that promotes learning, communication, diversity and satisfaction among students, faculty and staffEnhance our physical and technological infrastructure to support changes in the learning and work environmentExpand partnerships with Universities to provide advanced degrees to Pinal County residentsOptimize fiscal resources that support the needs and expectations of students and the communityContribute to the economic vitality, workforce development, and job training needs of Pinal County and surrounding region. |