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"Teaching Computing in Existing Laboratory Courses at CSUSB"

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Abstract:
This paper describes the evolution of computing in the chemistry department at a racially diverse comprehensive university, serving a large number of transfer and commuter students. Dissatisfaction with available computing facilities led a core group of faculty in the department to seek funding for establishing a networked departmental computing lab. In the process a rational plan for incorporating computing for mathematical and molecular modeling and communication throughout the curriculum was developed and implemented. By developing materials and providing formal and informal training, we enabled the less technically sophisticated faculty and adjunct instructors to use computing in their teaching. Computer applications are now embedded throughout the laboratory curriculum, including in-service courses such as "Chemistry in the Classroom", which targets pre-K-6 teachers. The computer lab is in high demand, and the department is committed to maintaining and upgrading the facility.

Opening remarks:
Most of you are using computers in the chemistry curriculum, and many are reporting their use. For example, a Google search run August 4, 2004 using the words "computing in the chemistry curriculum" scored about 23,000 hits (albeit many are far a field from the searcher's intent). More precisely, a search of the *Journal of Chemical Education Online* index [1] on the same day using the keyword "computer" found 1203 records. You may then be wondering what is unique about this paper, and whether you should read it. In fact, there few published studies [2] of the scope of this conference, computing across the curriculum. This paper describes the unique evolution of computing in chemistry at CSUSB.

Background

"Well-prepared students should emerge from a program in chemistry with . . . experience with computers, including an ability to use word processors, spreadsheets, numerical and nonnumerical algorithms, simulations and computation, data acquisition, and databases for information handling and retrieval . . ." ACT-CPT[3]

The American Chemical Society (ACS) Committee on Professional Training has developed guidelines and procedures for an ACS approved program.[3] In addition to the competencies outlined in the quote above, the document discusses the use of online databases for searching the chemical literature, and recommends using computer workstations for computational chemistry and molecular modeling. Zielisnki and Swift [4] name a number of competencies we should expect of chemistry graduates, such as word processing (including creating chemical structures and equations), scientific graphing, mathematical modeling and visualization, computer-instrument interfacing, and accessing materials from the WWW.

Chartered in 1960, the California State University, San Bernardino (CSUSB) is the sole public, comprehensive, regional university in the Riverside and San Bernardino counties of Southern California. As a medium sized campus of the 23-campus California State University system, the University offers more than 50 traditional baccalaureate and masters degree programs, with an emphasis on preparing K-12 teachers. The University serves almost 17,000 students from a service area extending over 29,000 square miles from the Arizona border to the Los Angeles county line. In the last decade, the area population has increased over 60 percent to a total of three million residents, where no racial or ethnic group is a majority. Our campus is designated a Hispanic Serving Institution.

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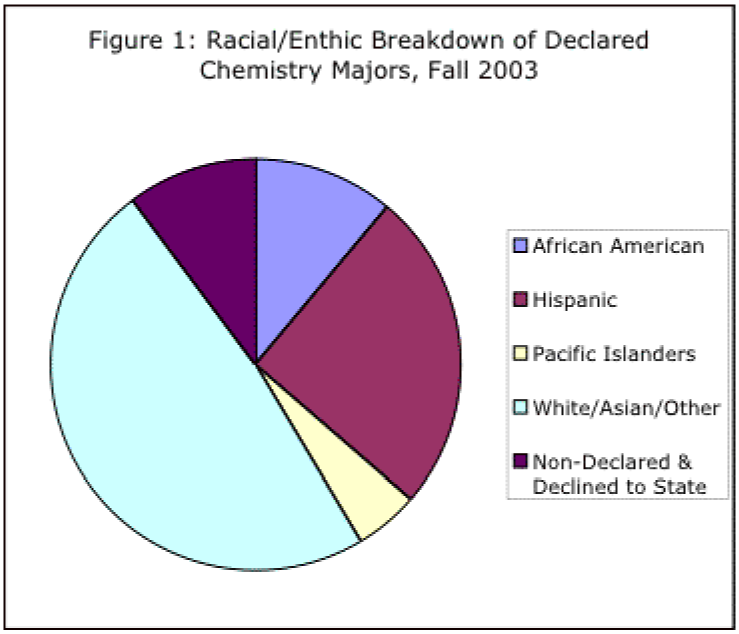
The *Department of Chemistry* at CSUSB (recently renamed *The Department of Chemistry and Biochemistry)* is comprised of twelve permanent faculty members and three full time support staff. Students enroll in one of four major tracks, with emphases in either chemistry or biochemistry at the BA and BS levels. The BS-ACS degree is certified by the American Chemical Society. The department offers a rigorous curriculum involving both teaching and research. Students majoring in chemistry mirror the diverse demography of the University service area. In the 2003-04 AY more than 37% of declared chemistry majorswere classified as underrepresented minorities (see **Figure 1**), and more than 60% were women. Up to half of our students begin their studies at other institutions, primarily area community colleges. In the past six years, our department has graduated a total of 108 chemistry bachelor degree candidates, of which ten are now teaching in area secondary schools, 16 entered MS or Ph.D. programs in the sciences, and ten entered medical, dental or veterinary school. The balance works in industry or government.



In 1997 the computing facilities in our department were abysmal, greatly limiting what could be accomplished in our courses. A handful of faculty hand-me-down computers were located in the corners of labs, a closet, and an empty office with a patchwork of software for student use. Many were not connected to a network or to the Internet. Other computing facilities on campus were not suitable, as they provided limited access, an inability to load chemistry-specific applications, and were located remote from our "wet" laboratories and faculty offices. Our departmental Assessment Plan, [5] developed in the mid-1990's, included as a goal ". . . to provide students with the opportunities to practice effective scientific computer, written and oral communications skills". We were not then meeting this goal, particularly in the area of computing**.**

To address the growing gulf between our reality and our ideal for student computing, four chemistry faculty representing a breadth of sub-disciplines established a computer committee (See **Table 1**). We decided to seek outside funding in order to leverage local resources and space.
The computer committee has been instrumental in all aspects of this project. The four original members worked together to create a vision for computing in the department. This included

addressing what we, and others,[3,4] believed to be core competencies, defining which courses in the curriculum would be used to introduce and build upon computer skills, and devising a plan for implementation and evaluation of learning. Much of this planning was accomplished while preparing a proposal for the NSF-ILI program in 1997, titled *A Unified Plan for Mathematical and Molecular Modeling Data Analysis and Chemical Communication in the Laboratory Curriculum.* [6] After funding was awarded, the committee worked to locate a room and oversee physical modifications and furnishings, purchase hardware and software, set up the computers and the network, and develop and implement the proposed curricular changes. The committee continues to meet regularly, in order to address ongoing laboratory issues, monitor computer use in the curriculum, and plan for the future.

Table 1: Faculty on the Chemistry Department Computer Committee

Faculty member	**Discipline**
Kimberley Cousins	Organic chemistry (committee chair)
Kenneth Mantei	Physical chemistry
Brett Stanley	Analytical Chemistry
John Tate	Inorganic Chemistry
Chris Brazier	*Physical/Introductory Chemistry (1998-2001 only)*
John Craig	*Chemistry Chair until 1999 (ex officio member)*
David Maynard	*Chemistry Chair 1999-present (ex officio member)*

The computer laboratory

Operative for more than five years, the computer laboratory has been used by multiple sections and offerings or more than 25 unique courses, and in excess of 3000 students. The main facility houses 14 Windows 2000 networked workstations and a dual processor Windows 2000 server. Also established was a six-workstation (4 Windows, 2 Macintosh) satellite laboratory, in addition to three rolling LabWorks stations. Two computational machines are available to allow advanced molecular and biomolecular computations. [7] Both labs are equipped with high volume laser printers, and a scanner is available in the satellite lab. The laboratory availability is M-F 8-5, with evening and weekend times through a permit system, or when classes are in session.

All workstations are equipped with the software listed *in black* in **Table 2**. Single copies of specialty software, listed *in red* in **Table 2**, are used primarily by research and upper division students. Software was chosen based on faculty experience and preference, as well as the availability of campus or CSU system site licenses or discounts. In several cases competing software packages were evaluated prior to making the purchases.

Table 2: Software applications available in chemistry computer laboratory

Application	Use in Courses	Vendor/Source
Microsoft Word	Preparing laboratory reports; course, seminar and research papers	Microsoft
Microsoft Excel	Spreadsheet/graphing of laboratory data; simple mathematical modeling	Microsoft
Microsoft PowerPoint	Preparing presentations for senior seminar, research presentations and posters	Microsoft
Microsoft QuickBasic	BASIC programming	Microsoft
Kaleidagraph	Scientific graphing of laboratory data	http://www.synergy.com/
PCSpartan Pro	Molecular mechanics, quantum mechanics calculations; molecule visualization	http://www.wavefun.com/
Labworks	Work with data from LabWorks probes; build methods	No longer available (formerly Bartlett and Jones)
CS ChemDraw Ltd	Chemical structure drawing	http://www.cambridgesoft.com/
Internet Explorer/Netscape Navigator	Internet Browsers	Microsoft and Netscape
Browser plug-ins: Java, Marvinsketch, Chime, Quicktime, Shockwave, Flash, RealPlayer, Acrobat Reader	To view sometimes dynamic and interactive web content	Various
Axum	High end scientific graphing	http://www.adeptscience.co.uk/
Macromodel	Molecular mechanics and dynamics	http://www.schrodinger.com/

Qsite	Substrate binding studies	http://www.schrodinger.com/
GaussianW	Computational chemistry package	http://www.gaussian.com/
GAMESS-US	Computational chemistry package	http://www.msg.ameslab.gov/GAMESS/GAMESS.html
Jaguar	Computational chemistry package	http://www.schrodinger.com/
MOLEKEL	Visualization of computational results	http://pobox.cscs.ch/molekel/
ShelX	Crystallographic data analysis	http://shelx.uni-ac.gwdg.de/
ChemOffice Ultra	High end chemical drawing; 3-D modeling and analysis; chemical database building	http://www.cambridgesoft.com/
GRAMS	Analysis of spectroscopic data	http://www.adeptscience.co.uk/
SPSS	Statistical analysis package	http://www.spss.com/

Given the limited size of the available room, and our desire to have students working in pairs in instructional laboratories, we chose a fourteen-workstation configuration in the main lab. This allows us to bring an entire section of a traditional laboratory course (enrollment up to 24 students) into the computer laboratory for guided instruction. A white board has been essential for instructional use, as well as for communicating with computer users, and a calendar is posted on the wall to avoid conflicts between scheduled classes. The satellite lab has proven useful for accommodating individual students during formal instructional sessions in the main computer lab, and for providing additional workstations during the busiest portions of the quarter. In addition, the satellite lab is on the same floor as the physical chemistry wet lab, enabling the instructor to easily cycle between the computer and wet laboratory.

A networked system, while harder to set up and maintain, maximized our computing resources. Thus we invested in a Windows NT (updated to Windows 2000 Professional) server with large redundant hard drives, and backup capabilities. Each workstation requires password access. This allows control and monitoring of student activity in the lab and on the Internet, while providing each student with central storage space, so that their preferences and files appeared the same regardless of the workstation used. Having a network also enabled us to purchase fewer copies of some specialty software (PCSpartan Pro, ChemDraw, MathCAD). As long as the maximum the number of licenses is not exceeded, these programs can be accessed from any Windows computer in the lab, or in the department. The server vendor helped us set up the network initially, and a series of student assistants (with periodic technical help from campus staff and faculty) have maintained and upgraded the network. We have found it necessary to purchase third party server software to assist maintaining our accounts and computers (see **Table 3**). Even with this additional software, maintaining, entering, and deleting of lab accounts, occasional "reimaging" (clearing off and reinstalling all software from an image) of machines, and dealing with technical problems, including maintaining antivirus and systems security updates is a labor intensive process. Our department invests more money annually in our computer laboratory student assistant than in the multiple students who prepare chemicals and solutions for our "wet" laboratories (about 120 lab sections per year).

Table 3: Auxiliary Server Applications

Product Name	Product Version	What it does	Vendor website
Symantec GhostCast Server	7.5.0.335	Creates workstation "image" that is stored on the server then loaded onto each reformatted workstation	http://www.symantec.com/product/
PrintManager Plus	5.0.0.32	Allows administrator to set printing limits (and monitor printing) for each account	http://www.softwareself.com
UserManagmeNT	5.4, Build 1853	Create, move, delete, audit accounts easily	http://www.tools4ever.com
SpaceGuard SRM	5.2, Build 1053	Monitor and enforce space quotas for accounts	http://www.tools4ever.com
Veritas Backup Exec	8.50	Automatic backup of server to tape	http://www.veritas.com/

Computers in the chemistry majors' curriculum

Table 4 summarizes uses of specific computing applications in the chemistry curriculum. The courses are listed in the order normally taken by chemistry majors (although all students do not take all courses, and some students take courses out of sequence). Many non-majors take general chemistry, organic chemistry, quantitative analysis, and the first biochemistry course, as well. As the table indicates, no more than two or three new software packages are used in any one course or sequence, and software applications introduced early in the curriculum are reused in subsequent courses. Used primarily in laboratory sections, these programs teach mathematical and molecular modeling, and chemical communication using modern tools.

Table 4: Student use of computer applications in the Chemistry Curriculum

Course/Program	Kaleidagraph (graphing)	MS Word	MS Excel	Computer-Interfaced instruments	PCSpartan Pro (molecular modeling)	ChemDraw Ltd.	Online literature searching	Browser/Chime	LabWorks Stations	MS Basic	MS PowerPoint	Specialty applications
Chem. 215/216 (General Chem.)	X	X										
Chem. 245 (Quantitative Analysis)		X	X	X								
Chem. 221-223 or 321-323 (Organic Chem.)		X	X	X	X		X					
Chem. 436/437/439 (Biochemistry sequence)	X	X		X			X	X				
Chem. 455.456 or 451/452 (Physical Chemistry)		X	X	X	X					X		
Chem. 475 (Inorganic Chemistry)		X	X	X	X							
Chem. 500 (Special Topics in Chemistry)		X	X	X	X	X	X	X			X	X
Chem. 545 (Instrumental Analysis)		X	X	X					X			X
Chem. 590 (Chem. Seminar)		X				X	X				X	X

Research	X	X	X	X	X	X	X	X	X	X	X	X

This sequence of applications in the curriculum fosters an evolving sophistication with computer use. As an example, students in general chemistry are expected to prepare laboratory reports with a word processor, and are introduced to scientific graphing using Kaleidagraph. However, sophisticated features such as subscript/superscript, equation building, and pasting graphs into reports are not required. In the subsequent physical chemistry courses students learn to prepare professional reports, incorporating graphs and diagrams in the document, and properly formatting formulas and equations.These skills are further reinforced when preparing a written paper for the Chemistry Seminar class, Special Topics courses, and undergraduate research.

Likewise molecular modeling with PCSpartan Pro is also used progressively throughout the curriculum. In organic chemistry students build, set up calculations and view molecules in order to better understand organic structure and reactivity. In physical chemistry they use vibrational analysis to complement an experiment in spectroscopy, and in inorganic chemistry they must build and calculate a structure for ferrocene, to demonstrate an understanding of coordination chemistry. A special topics course in computational chemistry builds on these earlier experiences by providing additional theory, as well as an opportunity for students to execute and present a small research project using PCSpartan Pro.

Students performing undergraduate research rely heavily on the computing faculties in conducting their projects and reporting the results. This includes using computing in the research (i.e. analyzing experimental data, conducting literature searches, performing computer modeling studies), and in preparing required final reports, as well presentations or posters at campus and professional conferences. For a representative list of recent departmental student presentations, see**Appendix 1**.

A unique feature of our campus is the large number of transfer students entering our program. For example, 26% of student enrolled in physical chemistry in 2003-04 had completed some or all of their lower division coursework elsewhere. Continuing students often assist transfer students in learnng to use the software applications. The "paired student" set up of our instructional sessions is particularly helpful in building this peer teaching environment.

Other curricular enhancements

Most of the department's faculty have course web pages and/or use other web sites (including publishers' sites) to support their courses for majors and non-majors. The computer lab enables us to utilize all the features of these sites, as students are assured that the correct browser configurations and plug-ins will be available. In addition to manipulating organic, inorganic, and bimolecular structures, we ask our students to view instructional animations and Java-based simulations. Many students have difficulty configuring their home computers to navigate these web sites, and other campus labs are not necessarily set to the configurations we need. This past year the author used the OWL homework package [8] in organic chemistry. This package required the use of a particular version of Java and MarvinSketch, in addition to Shockwave and Chime plug-ins. Over 20% of the enrolled students used the chemistry computer lab as the primary site for completing these assignments.

Chemistry 304, *Chemistry in the Classroom*, is an introductory chemistry course taken by up to 500 future K-8 teachers each year. This course was revised in 1999 to include Internet support and activities. We developed the Chemistry 304 Home Page to provide resources, to both the multiple course instructors, as well as the students/future teachers enrolled in the course. [9]. Three new laboratory activities were developed that introduced course enrollees to chemistry resources on the Internet, while reinforcing course content. [10] These activities would not have been possible without access to the chemistry computer laboratory.

Implementation

As seeking outside funding was the impetus for the planning of our curricular changes, justifying the funding provided us the motivation to fully implement the plans. Each committee member, in addition to other interested faculty, helped develop materials for their own and related courses. These materials include student handouts and software "templates" for specific applications. Descriptions of many of these applications are available on our computer laboratory web page. [11]

Without faculty training and support, these materials would not be used consistently. Several department members have attended workshops on computer and Internet applications available through our campus' Teaching Resource Center or Academic Computing and Media . One committee member (Tate) spent his sabbatical learning to use crystallography software, another (the author) used hers to update her skills in computational chemistry, and a third faculty member (Pederson) gained competence with web-based tools for protein and nucleic acid analysis. The author also presented a workshop to six interested faculty members on using PCSpartan Pro. In addition, more experienced faculty members often attend the initial instructional sessions in the computer lab, to assist both the students and the less experienced instructors.

Evaluation

The primary measure of the success of our project is that students are using the computer lab for chemistry related work, and using it often. In each recent quarter, 20 or more formal class sessions have been scheduled in the computer lab. The chemistry computer lab is in almost continual use by individual students, and fills up completely during the final weeks of each quarter. Along with our student study room, the computer lab and satellite lab serve as "hubs" for chemistry students to meet and consult. This past year we had to delete inactive student accounts several times, in order to keep the total number under 500 (our licensed quota).

In accordance with the Chemistry Department Assessment Plan,[5] we evaluate computer competence in the second quarter physical chemistry laboratory course. Students are expected to modify simple BASIC programs, use quantum mechanics software, employ spreadsheets, perform non-linear curve fitting of experimental data, and submit laboratory reports in a timely manner. As this laboratory relies heavily on computer use, it is expected that students who pass the laboratory portion of the course with a C or better have met the assessment criteria. In the four assessment cycles completed, all students have met this criterion.

Finally, we distribute surveys to graduating seniors in an effort to improve our program. Prior to opening the computer lab, a significant number of respondents cited inadequate computing facilities and instruction as a weakness of the program. Since that time, *no* respondent has mentioned computing in the chemistry curriculum as an area for improvement.

Continued evolution and future

The department is moving into a new Chemical Sciences building beginning March 2005 (currently under construction). The department demonstrated its commitment to computing during the planning for the new building. Included will be a main student computing laboratory, a "mobile lab", and computational machines. The main computer lab will be similar in to our current lab, with a networked server, 13 PCs, scanner and printer, and will be located adjacent to upper division wet laboratories. The mobile lab will consist of laptops that can use the wireless network to access to the chemistry server. Thus, students will be able to record and analyze data, and perform modeling during the instructional laboratory periods without leaving the scheduled rooms, and later retrieve these files from the main computer lab for inclusion in lab reports and other documents. The laptops will be stored on a cart to recharge, and may be transported to any teaching lab or lecture room in the building. By using the mobile lab for instructional periods, the main computer lab will remain open for student use throughout the day.

Acknowledgements
Financial support was provided by the NSF (NSF-ILI Award #9851333) and the College of Natural Sciences at CSUSB. Much appreciation is extended to members of the computer committee, other department faculty, student lab assistants, and college staff in making our program a reality. Special thanks go to John Craig for facilitating the laboratory remodel.

Endnotes

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[1] Journal of Chemical Education Online
Index: http://www.jce.divched.org/Journal/Search/index.html.

[2] For examples see: Computing Across the Chemistry Curriculum at the University of Pittsburg, http://chemed.chem.pitt.edu/cacc/default.htm accessed August 2004; Symposium on Integrating Computers into the Undergraduate Chemistry Curriculum, 15th Biennial Conf. on Chemical Education, August 9-13, 1998, Waterloo Ontario Canada; Symposium schedule is available at the following link maintained by Harry E. Pence, Professor of Chemistry, SUNY

Oneontahttp://employees.oneonta.edu/pencehe/bcce98.html accessed August 2004;Paselk, R. A. Zoellner, R. W. "Molecular Modeling and Computational chemistry at Humbolt State University," *J. Chem. Educ.***2002** , *79* , 1192-1194; Gordon, N. R. Newton, T. A. Rhodes, G. Ricci, J. S. Stebbins, R. G. Tracy, H. J. "Writing and Computing across the USM Chemistry Curriculum," *J. Chem. Educ.***2001** , *78* , 53-55; Jones, M. B. "Molecular Modeling in the Undergraduate Chemistry Curriculum", *J. Chem. Educ.* **2001** , *78* , 867-868; Martin, N. H. "Integration of Computational Chemistry into the Chemistry Curriculum," *J. Chem. Educ* . **1998** ,*75* , 241-243; *Using Computers in Chemistry and Chemical Education;* Zeilinski, T. J.; Swift, M. L., Eds.; American Chemical Society: Washington, D. C.**1997** and articles therein.

[3]"Undergraduate Professional Education in Chemistry, Guidelines and Procedures" Spring 2003 American Chemical Society Committee on Professional Training.

[4] Zielinski, T. J.; Swift, M. L "What Every Chemistry Should Know about Computers, II" *Chem. Educator* [Online] **1997**, *2*(3), DOI 10.1333/s00897970122a. First presented during ChemConf"97: On-Line Conference on Chemical Education.

[5] Department of Chemistry (now Chemistry and Biochemistry) Assessment Plan. The complete document can be obtained athttp://gradstudies.csusb.edu/outcome/ChemistryBA_BS.pdf , accessed August 2004.

[6]NSF Award Abstract - #9851333, http://www.nsf.gov/awardsearch/showAward.do?AwardNumber=9851333 Accessed August 2004.

[7] Single processor Pentium IV Windows 2000 and dual processor Pentium V Linux OS machines, respectively.

[8]Thomson Learning, University of Massachusetts at Amherst, to accompany McMurry, "Organic Chemistry," 6th ed. Brooks-Cole,http://owl2.thomsonlearning.com/

[9] Chemistry 304 home page: http://chem.csusb.edu/~chem304 Accessed August 2004.

[10] See experiments 3, 4 and 5 in the Chem. 304 laboratory manual: http://chem.csusb.edu/~chem304/studentresource/304labmanualW04.pdf Accessed August 2004.

[11] The Chemistry Computer Laboratory Home page gives more details of specific assignments (follow the "Assignments" link):http://chem.csusb.edu/~kcousins/ilipage/computerlab.html Accessed August 2004.

Appendix I: Representative Recent Undergraduate Research Presentations in Chemistry:

1. McConnell, Dwain (Cousins, K.R.) "Green Chemistry: Synthesis of Sesamol Allyl Eth er, the First Step in the Synthesis of Carpanone", CSUSB McNair Scholar"s Symposium, August 5, 2004.
2. Rice, A. (Cousins, K. R), "Preliminary QSAR Analysis of Novel Cooling Compounds," CSUSB Undergraduate Research Symposium *First Place* , March 2003; also presented at CSU-Wide Research Competition, CSU Chico, May 2003
3. Bell, J. M. (Cousins, K. R.) "Semi-Empirical PM-3 Analysis of a and b D-Aldohexoses in Equilibrium" Biennial Meeting of the CCC of the CSU, San Bernarndino, July 9, 2001.
4. Reiter, O. Cousins, K. R. "Using Phase Transfer Catalysis in the First Step of the Synthesis of Carpanone", National Meeting of the American Chemical Society, San Diego, CA, April 2, 2001.
5. Bell, J. M. (Cousins, K. R.) "Qualitative Analysis of Nicotinamide", SC-ACS Student Affiliate's Research Conference, April 2000; CSUSB and CSU Research Competitions, 2000.
6. Ramirez, J. (Cousins, K. R.) Mowrey, B. "Using 2-D C-H NMR Spectroscopy to Completely Assign the Spectra of Intermediates in the Synthesis of Carpanone," CSUSB Research Competition, April 1998, and CSU System-Wide Undergraduate Research Competition, May, 1998.
7. RaeAnne E. Falvo, Van T. Nguyen, D. Michele Smith, Larry M. Mink, Robert K. Boggess, Heather Washburn. "Synthesis of Pt(IV)-Tetraphenylporphyrins Via Direct Oxidative Addition". Inorganic Section, ACS National Conference, San Francisco, CA, 8. April 1997.
8. D. Michele Smith, Van T. Nguyen, RaeAnne E. Falvo, Larry M. Mink, Robert K. Boggess, Heather Washburn, Dennis I. Grove. "Synthesis and Electrochemistry of $[Pt^{IV}(para\text{-}X)_4TPP]Br_2$Complexes". Inorganic Section, ACS National Conference, Las Vegas, NV, (Attachment #113), September 1997.
9. John W. Voce, "Synthesis and Investigation of Platinum Tetraphenylporphyrins" at the Twelfth Annual CSU Student Research Competition , Chico, CA, April 1998
10. Laura Saucedo, "Microscale Synthesis and ^{1}H NMR of Zn(II) and Ni(II) Para- substituted Tetraphenylporphyrins" at the American Chemical Society National Conference, Orlando, FL, April 2002.
11. "The Synthesis and Biological Activity of Avocadofurans." Joshua Hoergerand D. F. Maynard, CUSUB Undergraduate Research Competition: March 10,1997 *First Place*
12. "A New Group of Insecticidal Compounds from Idioblast Cells of Avocados" Rodriguez, C. S.; Millar, J. G.; Maynard, D. F.; Trumble, J. T., ESA Annual Meeting, Nashville, Tennessee, December 14-18, 1997.
13. "The Synthesis of Even-Chained Avocadofurans" Scott Phillips andD. F. Maynard, 216th National Meeting of the American Chemical Society, August 23-27, 1998, Boston, MA.
14. "The Use of Experimental Archaeology in Reconstructing Aztec Super Glue", Ed Stark, (David F. Maynard and Frances Berdan) 34th ACS Western Regional Meeting,San Francisco, CA, October 28, 1998.
15. The Analysis of Ancient Aztec Pottery Sherds" Carolyn Cardellio (Drs. Frances Berdan and David Maynard), Cal Poly Pomona, November 21, 1998
16. "Studies on the Deprotection of Silyl Ethers: Inhibiting a Cyclization Reactions" Corrie Kuniyoshi, (Dr. David Maynard), SCCUR Cal Poly Pomona, November 15, 1999
17. Coope, S. "Effects of alpha and beta-hydroxylallenyl phospine oxide on the growth of human breast carcinoma cells" 221st National ACS Meeting, San Diego, CA April 2, 2001
18. Wood O"Jon, R. " Synthesis and biological activity of alpha-hydroxyallenes,, 221st National ACS Meeting, San Diego, CA April 2, 2001
19. Nadal, Laura, F. Berdan, D. F. Maynard, "An exceptional sample of feathers: Identification of the manufacturing techniques." 5th Congress of Ethnobiology, Chapingo, Mexico, Nov 15, 2003
20. Mr. Juan Castro delivered a Poster Presentation at the McNair Scholar's Program National Conference at Penn State University on August 13, 1998.Castro, Juan; Smith, Douglas. "Approaches to the Synthesis of Dihydrofurans and Tetrahydrofurans."
21. "Modeling Peak Profile Asymmetry of Basic Compounds in Reversed-Phase High Performance Liquid Chromatography", J.R. Krance and B.J. Stanley, 221 st National Meeting of the American ChemicalSociety, San Diego, CA, April 2, 2001.

22.."Determination of the Thermodynamic Contribution to Peak Asymmetry of Basic Solutes in Reversed-Phase Liquid Chromatography", A. Roy and B.J. Stanley, 14th Annual Student Research Competition, California State Polytechnic University, Pomona, CA, May 5, 2000.

23."Determination of the Thermodynamic Contribution to Peak Asymmetry of Basic Solutes in Reversed-Phase Liquid Chromatography", A. Roy and B.J. Stanley, 1999/2000 Student Research Competition, California State University, San Bernardino, CA, March 1, 2000.

24."Prediction of Chromatography Peak Tailing Using Isotherms", J.J. Geraghty and B.J. Stanley, 8th Annual CSUSB Student Research Conference, California State University, San Bernardino, CA, June 5, 1998.

25."Prediction of Chromatography Peak Tailing from Isotherms", J.J. Geraghty and B.J. Stanley, 8th Annual New Directions Undergraduate Research Conference, University of California, Riverside, CA, May 16, 1998.

26."Prediction of Chromatography Peak Tailing from Isotherms", J.J. Geraghty and B.J. Stanley, 12th Annual CSU Student Research Competition, California State University, Chico, CA, May 2, 1998.

27."Prediction of Chromatography Peak Tailing from Isotherms", J.J. Geraghty and B.J. Stanley, 1997-98 Student Research Competition, California State University, San Bernardino, CA, March 11, 1998.

28."Chromatogram Peak Prediction in C18 Reversed-Phase High Performance Liquid Chromatography", J.J. Geraghty and B.J. Stanley, Southern California Conference on Undergraduate Research, California State University, Los Angeles, CA, November 22, 1997.

29.Maryam Rejali,Ali Reza Rejali (Yang), " The Cellular Mechanism of Nicotine-Induced Coronary Artery Disease"227th American Chemical Society National Meeting, Anaheim, CA, 2004.

30.Maryam Rejali (Yang), first place at the 11th California State University San Bernardino (CSUSB) Research Conference, and first place in the 18th Annual CSUSB Student Research Competition.

31.Ali Reza Rejali (Yang), first place at the 14th Annual CSUSB Student Research Conference.

32.Christi Bonar, Jamie Estrella (Yang), "Effect of Glucocorticoid on Coronary Artery Endothelial Function", 221st American Chemical Society National Meeting, San Diego CA, 2001.

33.Kestrel Rogers, (Yang) "MgATP induced- conformational change of the c-subunit of cyclic-AMP dependent protein kinase",2002 Southern California Undergraduate Research Conference in Chemistry and Biochemistry. California State University,April 13, 2002 .

34.Joe Hernandez (Yang) "Cigarette Smoking and Coronary Heart Disease", at the National McNair Scholar Conference at University of New York, Buffalo (2003)

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