

# MSU INVESTMENT PROPOSAL FOR INSTITUTIONAL PRIORITIES

## PROPOSAL OVERVIEW

<b>Title</b>	Quantitative Laboratories for Scientists and Engineers	<b>Request Date</b>	16 December, 2011
<b>Department</b>	Chemistry and Biochemistry	<b>Email</b>	<a href="mailto:rawalker@chemistry.montana.edu">rawalker@chemistry.montana.edu</a>
<b>Requestor</b>	Dr. Robert A. Walker	<b>Phone</b>	406-994-7928

## STRATEGIC ALIGNMENT

**Core Themes and Objectives (check all that apply)**

### Educate Students

- Our graduates will have achieved mastery in their major disciplines
- Our graduates will become active citizens and leaders
- Our graduates will have a multicultural and global perspective
- Our graduates will understand the ways that knowledge & art are created and applied in a variety of disciplines
- Our graduates are prepared for careers in their field
- We will provide increased access to our educational programs
- Communities and external stake holders benefit from broadly defined education partnerships with MSU

### Create Knowledge and Art

- Students, faculty, and staff will create knowledge and art that is communicated widely

### Serve Communities

- We help meet a fundamental need of the citizens of Montana by providing degree programs for our students
- We help meet the educational needs of the citizens of Montana by providing a wide range of educational opportunities to a variety of students
- Our students, faculty, staff, and administrators reach out to engage and serve communities
- Our students, faculty, staff, and administrator reach in to build the university community

### Integrate Learning, Discovery, and Engagement

- Each graduate will have had experiences that integrate learning, discovery and engagement
- Outreach activities will educate students and address the needs of the communities we serve
- Students, faculty, and staff will create knowledge and art that addresses societal needs
- MSU is a community that will be characterized by synergy within and across disciplines, roles and functions.

### Stewardship

- The public trusts the institution to operate openly and use resources wisely
- The faculty and staff are well-qualified and supported
- MSU will support Native American students, programs, and communities
- MSU will be an inclusive community, supporting and encouraging diversity
- Our publicly provided resources are used efficiently and effectively
- Natural resources are used efficiently and sustainably
- MSU nurtures a culture of resource conservation and ecological literacy among students, faculty and staff
- Our physical infrastructure (e.g., building, equipment, open spaces) will be well-maintained and useful

**INSITUTIONAL BENEFIT**

<b>Campuses</b>	<input checked="" type="checkbox"/> Bozeman <input checked="" type="checkbox"/> Billings <input checked="" type="checkbox"/> Havre <input type="checkbox"/> Great Falls <input type="checkbox"/> FSTS <input type="checkbox"/> Extension <input type="checkbox"/> MAES
<b>Cross Depts</b>	Please List: _____

**TIMEFRAME**

<b>Proposed Dates</b>	Start: _____	End: _____
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**COST AND REQUIREMENTS**

Funding Type	One-Time (\$)	Multi-Year (\$)			Base (\$)	FTE
		Year 1	Year 2	Year 3		
Personnel (w/benefits)		\$54,800 <sup>1</sup>	\$54,800 <sup>1</sup>			See below <sup>1</sup>
Materials & Supplies		\$8,000 <sup>2</sup>	\$8,000 <sup>2</sup>			
Travel		\$1000 <sup>3</sup>	\$1000 <sup>3</sup>			
Contracted Services						
Capital		\$45,000 <sup>4</sup>	\$36,000 <sup>5</sup>			
Other Operations		\$2,500 <sup>6</sup>	\$2,500 <sup>6</sup>			
<b>TOTAL</b>		<b>\$111,300</b>	<b>\$102,300</b>			

<p><b>Please comment, if necessary, regarding cost and requirements.</b></p>	<p><sup>1</sup>As detailed in the Project Description, our plan to develop new methods and content for teaching quantitative and instrumental analysis will involve faculty and instructors from MSU-Bozeman, MSU-Billings, and MSU-Northern. Furthermore, the project will provide opportunities (and partial financial support) for undergraduate and graduate students intending to pursue careers in education by enabling these students to participate in the development of new laboratory activities. Personnel costs will provide \$7,000 per faculty/instructor participant per year (primarily for summer support when the laboratory activities are developed and tested) and \$4,000 per undergraduate/graduate student participant per year (again primarily for summer support). Benefits are calculated at a rate of 25% per faculty/instructor and 8% per student.</p> <p><sup>2</sup>An approximate breakdown of materials and supplies is \$2,000 per year for MSU-Billings and MSU-Northern and \$3,000 per year for MSU-Bozeman (due to MSU-Bozeman's larger student numbers).</p> <p><sup>3</sup>Travel is intended to cover a total of 4 trips (that bring Bozeman participants to Billings and/or Havre and vice versa). Costs are estimated using a rate of \$0.25 per mile and a per-diem of \$50 for food.</p> <p><sup>4</sup>Capital equipment in Year 1 covers the cost of three (3) atomic absorption spectrometers, one for each participating institution.</p> <p><sup>5</sup>Capital equipment in Year 2 covers the cost of three (3) bomb calorimeters, one for each participating institution.</p> <p><sup>6</sup>Other operations – 1-2 workshops per year are anticipated that bring together all team participants for the express purpose of ensuring that laboratory exercises, procedures, and evaluation standards are consistent across all institutions and appropriate for the students at each individual institution. Costs for these workshops will include lodging, food, and miscellaneous expenses for up to nine (9) participants.</p>
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## PROPOSAL SCOPE

### Describe the Proposal

The Departments of Chemistry and Biochemistry at three Montana State University campuses (Bozeman, Billings and Northern) propose to restructure several of their quantitatively-focused laboratory courses in order to provide better training and more effective pedagogy for both department majors and for a broad cross section of science and engineering students. The focus of this 2-course sequence will be Chemistry 311 (CHMY 311), a 300-level, 4 credit lecture/laboratory course focused on developing quantitative analytical skills applied to solving problems in environmental and bioanalytical chemistry. Additional efforts will build upon the skills taught in CHMY 311 and develop content to be used in Chemistry 421 (CHMY 421), a 3 credit course that allows students to learn the operating principles and assess the accuracy of advanced scientific instrumentation. While CHMY 421 is offered only at MSU-Bozeman and MSU-Billings, content developed for this course will be able to be transferred in part to related courses at MSU-Northern.

The laboratory activities themselves will be grouped into one of two categories: bio-analytical chemistry and environmental chemistry. Depending on the semester and the intent of the instructor, courses will focus on one theme or the other. However, regardless of the topic *skills* being taught in CHMY 311 and CHMY 421 will remain the same: CHMY 311 will emphasize quantitative measurements and analyzing data statistically to evaluate experimental precision, accuracy and confidence. CHMY 421 will focus on *how* instruments work and stress the importance of matching questions being asked to the capabilities of the technique being used. CHMY 421 will conclude with capstone projects that require students to design their own experiments and answer questions that they themselves have devised. CHMY 311 and 421 will cultivate skills essential for all students who aspire to careers in science and/or engineering, thus we expect that this project will have impact on all campuses that extends beyond the boundaries of a single department. Informal conversations with colleagues in the MSU-Bozeman Departments of Chemical and Biological Engineering, Cell Biology and Neuroscience, and Land Resources and Environmental Sciences affirm that the goals of CHMY 311 and 421 dovetail closely with outcomes desired in their own students. Consequently, both CHMY 311 and 421 are likely to have enrollments that span a broad cross section of science and engineering disciplines.

Some of the resources being requested for this project will be used to invest in capital equipment for each of the three institutions. In Year 1, \$45,000 will be used to purchase 3 atomic absorption spectrometers ( 1 for each participating campus). These robust, durable instruments are capable of measuring the elemental concentrations down to ppb (parts-per-billion) levels, and can be used for both biological and environmental applications. Similarly, Year 2 requests \$36,000 for three bomb calorimeters that can measure heats of formation for a wide variety of biologically and environmentally relevant samples. These instruments are used extensively in industry and federal laboratories, meaning that experiments developed around these two devices will provide necessary, hands-on training for MSU's graduates, many of whom find employment in state industries and regulatory agencies. Additional laboratory exercises for CHMY 311 and 421 will utilize instrumentation already present at the three campuses (including FTIR-spectrometers, emission spectrometers, viscometers, etc).

Course development will be carried out by a core team of tenure track and instructional faculty who have a long history of dedicated commitment to undergraduate education. Participants include: Professor Robert Walker (team leader, MSU-Bozeman), Assistant Professor Matthew Marlow (MSU-Billings), Assistant Professor Forrest Townes (MSU-Northern), Dr. William (Bill) McLaughlin (Instructor, MSU-Bozeman) and Dr. Jane Klassen (Instructor, MSU-Bozeman). These participants regularly teach CHMY 311/421 or classes directly impacted by these lab-intensive courses. This project will also provide support for undergraduate and graduate students intent on careers in high school or college science education. Specifically, participating faculty and instructors will work closely with and mentor student participants in the design, development and assessment of laboratory experiments.

## PROPOSAL SCOPE

### Describe the broader impacts and benefits of this proposal

Critical thinking skills are universal and vital for students intending to pursue careers in science, technology, engineering and medicine. Bringing together faculty from different institutions across the state to develop cooperatively the tools and content necessary for cultivating these skills will transform how science is taught at post-secondary institutions in Montana and, potentially, serve as a blueprint for science education in other rural settings that face similar challenges of diverse populations and limited resources. In addition to providing a more cohesive education for students, this program will also foster intellectual exchange and closer community between science educators across the state.

As noted above in the project description, the courses being targeted for restructuring – CHMY 311 and CHMY 421 – will provide service to students both in Chemistry and Biochemistry as well in other fields where quantitative accuracy and precision are needed. Consequently, this project will have broad impact that extends across the MSU campuses. Furthermore, the project will provide a cohesive, themed, hands-on educational experience to these students from different disciplines.

The impact of this project extends beyond simply the listing of courses and project descriptions one finds in the registrar's catalog. By bringing together faculty and students from different MSU campuses, this project truly embodies the "1-MSU" message that administration has begun promoting aggressively during the past two years. Establishing this nucleus of faculty and instructors committed to MSU's mission of creating knowledge by integrating learning, discovery and engagement creates a core group of professionals who will be well positioned to sustain their efforts through grants from agencies such as the National Science Foundation and the Department of Education. Furthermore, the project will provide tangible benefits to the students who enroll in these classes. Students who participate in content development will learn first-hand how to develop (and evaluate) effective, cohesive scientific curricula that spark student interest and help students cultivate the skills necessary to answer their own questions.

The MSU-Bozeman members of the team have particularly strong associations with Native American communities from different reservations across Montana. Specifically, Dr. McLaughlin has been working with secondary science teachers on the Crow reservation and secondary teachers working with native populations in other secondary education settings. He has been a leader in planning the analytical chemistry experiments with the Montana Apprenticeship Program (MAP) as part of the AIRO summer program on MSU's campus for the past five years. Dr. Klassen has worked closely with faculty at Salish Kootenai College to promote science literacy and awareness in the Flathead Valley. Her efforts culminated last May with a "Festival of Research" event that highlighted local research being done at SKC (and surrounding high schools) and provided hands-on science activities for the more than 125 attendees. Professor Walker – newly arrived at MSU-Bozeman in August, 2009 – has welcomed Native American interns into his research group each of the past two summers through MSU-Bozeman's MAP activities. During their summer experience, interns learn how to operate instruments, work independently on projects that fall within the overall umbrella of Walker's research program, *and* develop the communication skills they need to present their work both as an oral talk and as a poster.

Should the proposed project be supported, participants will work with science instructors at tribal colleges across the state to disseminate and adapt laboratory exercises so that the activities can be effective tools at institutions that may lack infrastructure found on the MSU campuses.

## ADDITIONAL INFORMATION

### Implementation Plan *(Please describe with timelines)*

If resources are awarded to this project prior to the end of AY 11-12, work will begin in Summer '12.



- May, 2012 – Purchase AA spectrometers
- June, 2012 – Program kick-off meeting/workshop, MSU Bozeman, assign tasks, establish timetable
- June-August, 2012 – Develop 8-10 experiments for CHMY311, CHMY421
- Fall 2012 – Implement first generation of experiments and assess.
- January, 2013 – Workshop prior to start of the S'13 semester; review assessment and make necessary changes
- Spring, 2013 – 2<sup>nd</sup> generation of CHMY 311 experiments; 1<sup>st</sup> generation of CHMY 421 experiments
- Spring, 2013 – Purchase bomb calorimeters
- June, 2013 – Progress report workshop; mid-point evaluation
- June-August, 2013 – Develop 8-10 experiments for CHMY 311 and CHMY 421
- Fall, 2013 – 3<sup>rd</sup> generation of CHMY 311 experiments
- Spring, 2014 – 4<sup>th</sup> generation CHMY 311; 2<sup>nd</sup> generation CHMY421.
- June, 2014 – Project wrap-up.

### Assessment Plan *(Please describe with indicators)*

As content is being developed and tested, assessment efforts will evaluate how effectively the courses are meeting their goals at all participating institutions. The assessments will provide feedback necessary for curriculum development to evolve and improve with successive classes of students. One team member – Professor Forrest Townes (MSU-Northern) – focused extensively on chemical education and assessment during his graduate studies (at UM-Missoula) and will lead all participants in developing the metrics used to measure the project's effectiveness.

### If assessed objectives are not met in the timeframe outlined, what is the plan to sunset this proposal?

The project described in this proposal represents the first step in a broader effort to provide students at the MSU campuses with a more cohesive, vertically integrated educational experience in chemistry. Consequently, the faculty and instructors comprising this team intend to pursue additional lines of support through programs sponsored by the National Science Foundation (Transforming Undergraduate Education in Science (TUES)) and the Department of Education (Graduate Assistance in Areas of National Need (GAANN)). This project being submitted to the MSU Budget Council will result in concrete, clearly defined milestones, but curriculum development never really ends. In order to continue to improve the way we serve our students, we will continue to work aggressively to become a national leader in the development of innovative tools and strategies that enable students to become better scientists.

SIGNATURES		
Department Head (please print)	Signature (required)	Date
Bern Kohler		12-21-2011
Dept Head Priority (please circle one):    Very High    High    [ Medium ]    Low    Very Low		
Dean/Director (please print)	Signature (required)	Date
Paula Lutz		1-3-12
Dean/Director Priority (please circle one):    Very High    High    (Medium)    Low    Very Low		
Executive/VP (please print)	Signatures (required)	Date
Executive/VP Priority (please circle one):    Very High    High    Medium    Low    Very Low		