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**IPEL Grant Application**  
**(Initiative to Promote Excellence in Student Learning)**  
**Minnesota State University, Mankato**

**PROPOSAL COVER PAGE**

Title of Project: *The Redesign of General Chemistry II to Promote Critical Thinking and Long term Learning*

Name: Marie K. Pomije

Are you full-time faculty in 2006-2007?      Yes    No  
(fixed-term faculty are not eligible to apply)

Do you plan to return to MSU in 2007-2008?      Yes    No

e-mail: marie.pomije@mnsu.edu

Campus Address: 242 N Trafton Science Ctr.

Campus Phone: 389-5917

College: CSET

Department: Dept of Chemistry

Spring Semester Schedule:

List times when available to participate in Learning Communities and workshops.

Mondays: 10:30-1

Tuesdays: 10:30-5

Wednesdays: 10:30-5

Thursdays: 10:30-5

Fridays: not available

Marie K Pomije  
Signature of Applicant

Brian L...  
Signature of Department Chair/Director/Supervisor

[Signature]  
Signature of College Dean/Vice President

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**IPESL Grant Application**  
(Initiative to Promote Excellence in Student Learning)  
Minnesota State University, Mankato

**PROPOSAL COVER PAGE**

Title of Project: *The Redesign of General Chemistry II to Promote Critical Thinking and Long term Learning*

Name: **John Thoenke**

Are you full-time faculty in 2006-2007?  
(fixed-term faculty are not eligible to apply)  Yes No

Do you plan to return to MSU in 2007-2008?  Yes No

e-mail: **john.thoenke@mnsu.edu**

Campus Address: **TN 242**

Campus Phone: **1718**

College: **CSET**

Department: **Chemistry and Geology**

Spring Semester Schedule:

List times when available to participate in Learning Communities and workshops.

Mondays: 1 - 5

Tuesdays: 1 - 4

Wednesdays: 1 - 5

Thursdays: 9 - 10

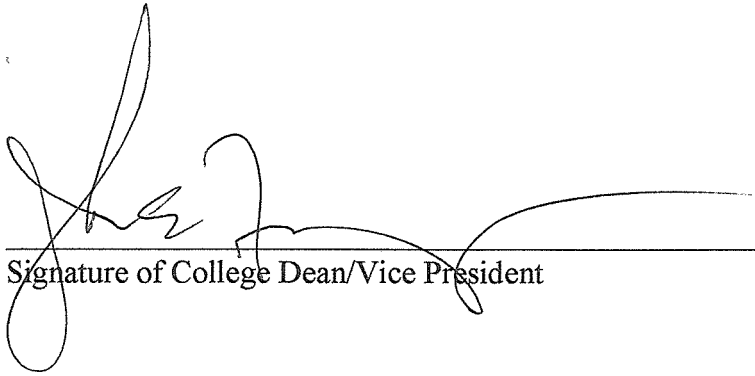
Fridays: not available

*John D. Thoenke*

Signature of Applicant

*Bruce L. L.*

Signature of Department Chair/Director/Supervisor

A handwritten signature in black ink, consisting of several loops and a long horizontal stroke extending to the right.

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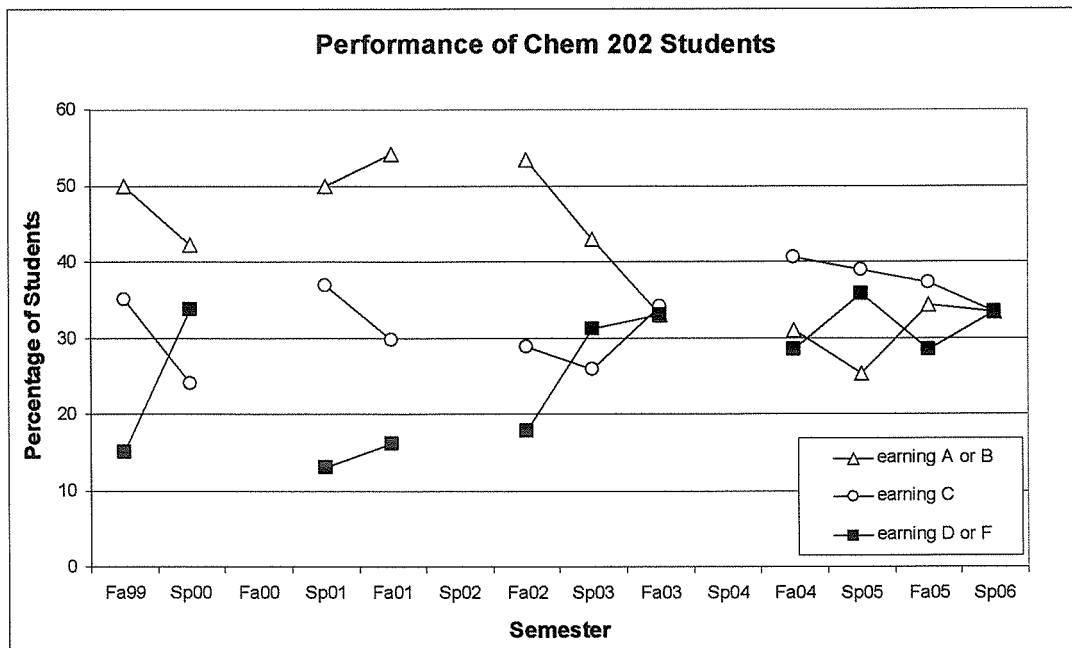
Signature of College Dean/Vice President



*IPESL Proposal:  
The Redesign of General Chemistry II to Promote Critical Thinking and Long term Learning*

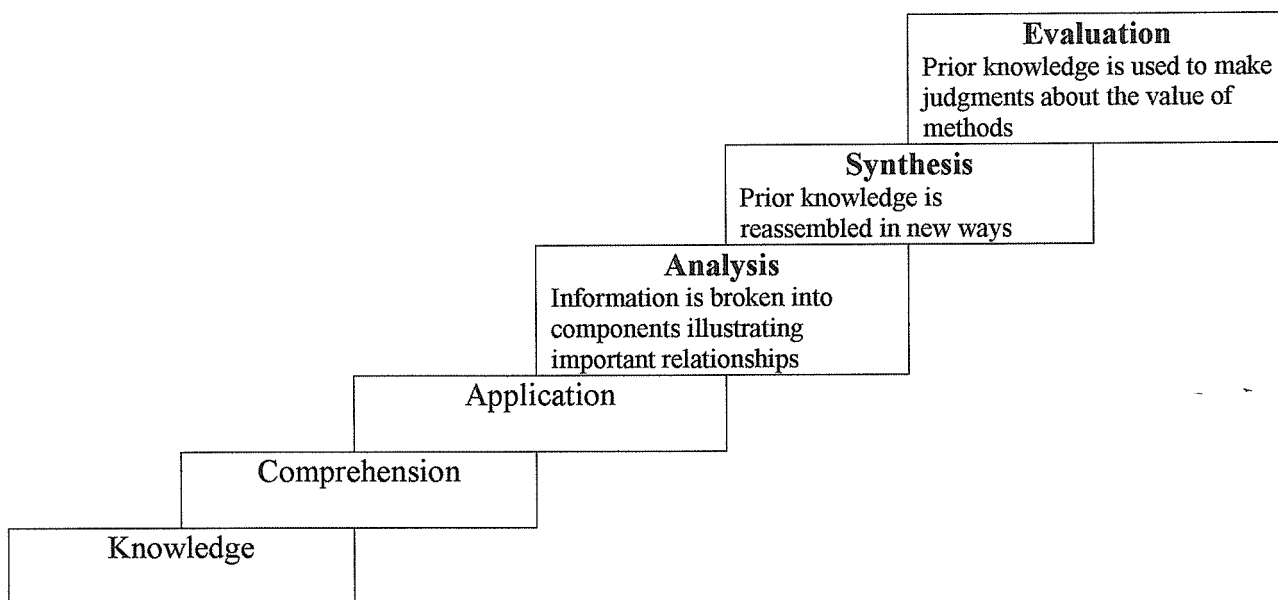
**Purpose**

We are concerned by a decline in the performance of students in the General Chemistry II course, and this project is intended to address these concerns and to incorporate a more consistent approach to the development of critical thinking skills for these students. In tracking student performance over the past 7 years, we note a general decline in the percentage of students earning A's and B's and a general increase in the percentage of students earning D's and F's. While not reflected in the graph below, we also have noted a significant increase in the number of students repeating this particular course.



These observations are consistent with trends noted by the National Academies.<sup>1</sup> Our general goal is to redesign the curriculum to more effectively meet the needs of this increasing population of students who struggle in General Chemistry II; as described in the next section.

While numerous philosophical approaches to cognitive learning are effective<sup>2,3</sup>, we base ours on the hierarchical taxonomy developed by Bloom<sup>4</sup>.



In General Chemistry II, we expect students to think critically by operating in the upper levels of Bloom's taxonomy, and in both the conceptual and mathematical dimensions. Effective problem-solving in chemistry requires strong conceptual and quantitative thinking to be used in concert.

### **Project Description**

Our project has two specific goals, both promoting the development of transferable skills needed for success in college and beyond:

- Develop online materials addressing baseline skills necessary for success in this course; including mathematics, reading comprehension, and retention of learning from General Chemistry I. These materials will be constructed to promote self-guided assessment and emphasize the synergy between mathematics and chemistry and the thematic nature of the foundations of chemistry.
- Create periodic workshop days to engage all students in solving chemistry-related application problems designed to require multi-dimensional (both conceptual and mathematical) critical thinking, incorporate peer-led techniques, and guided inquiry based learning overseen and mentored by faculty.

These goals are designed to address our unique situation and teaching philosophies. Our ideas are innovative in CSET and in the University because we are proposing a multifaceted approach to developing *two* dimensions of critical thinking and implementing this in the foundational courses in our field. From conversing with our CSET colleagues and students, we realize we are unique in recognizing the need to develop both dimensions and in articulating that to our students.

Additionally, our experiences and class meeting limitations lead us to address this through a multifaceted approach including active learning strategies incorporated in a large enrollment lecture and online materials that will add structure to student - driven self-assessment and review. In this way, we address both baseline skill acquisition (Bloom's lower levels) and actively engage the students in critical thinking (Bloom's higher levels), thus providing stronger learning opportunities for all students.

### Assessment

The table below contains our assessment strategies.

Goals	Outcomes	Assessment Tools
Develop online materials.	To develop a culture of self assessment. To communicate clearer expectations of baseline mathematical skills and reading comprehension skills needed for success. To reinforce the synergy between mathematics and chemistry. To reinforce the importance of retention and application of concepts from previous course(s) to more advanced problem solving processes.	1-use of online materials 2-performance on assessed materials 3- questionnaire feedback 4-reflective faculty evaluation 5-performance on the ACS standardized general chemistry exam
Create periodic workshop days.	To develop and implement active learning workshop days that focus on development of critical thinking skills. To create faculty mentored situations where each student can apply critical thinking skills.	see 1-5

Developing materials addressing both of these goals, implementing them in the spring term, refining them for summer term, and assessing their effectiveness within the specified timeline requires the full participation of both faculty members.

### Project Dissemination

We anticipate that the results of this project will provide useful information to other instructors of foundational science courses. We envision dissemination activities to include publication in an appropriate venue such as *The Journal of Chemical Education* or *The Chemical Educator*. We would also welcome opportunities to present our findings at local, regional or national meetings.

This proposed project will enhance the curriculum and diversify learning experiences for students enrolled in General Chemistry II. Strengthening this foundation should lead to firmer footing and translate to undergraduate excellence in the many programs that the general chemistry sequence serves including chemistry, biochemistry, biology, physics, engineering and science teaching/secondary professional education.

### Department and University Goals

Within the Department, this project supports the goal of enhancing curriculum. Within the college, it supports the goals of developing highly educated alumnae<sup>5</sup>. Within the University, this project supports the goals articulated by the strategic priority for undergraduate academic excellence including fostering critical thinking<sup>6</sup>.

**Endnotes:**

<sup>1</sup>The National Academy of Sciences, The National Academy of Engineering and The Institute of Medicine of the National Academies. *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*, The National Academies Press, Pre-publication version, February 2006 edition. open book 2 November 2006. <<http://fermat.nap.edu/books/0309100399/html>>)

<sup>2</sup> Bransford, J., A. L. Brown and R. R. Cocking, eds. *How People Learn Brain, Mind, Experience, and School, Expanded Edn.*, National Academy Press, 2000.

<sup>3</sup>Glover, J. A., R. H. Bruning and R. W. Filbeck. *Educational Psychology Principles and Applications*, Boston, Little, Brown and Company, 1982.

<sup>4</sup>Bloom, B.S. ed. *Taxonomy of Educational Objectives: The Classification of Educational Goals*, New York: McKay, 1956.

<sup>5</sup> “College of Science, Engineering and Technology Mission and Goals” *Minnesota State University Mankato*, 19 November, 2006. <<http://cset.mnsu.edu/about/mission-goals.html>>

<sup>6</sup> “Academic Excellence Taskforce Report” *Minnesota State University Mankato*, 2 November, 2006. <<http://www.mnsu.edu/president/priorities/reports/priority5.html>>