**General Education Course Inclusion Proposal**

**SCIENTIFIC INQUIRY**

*This proposal form is intended for departments proposing a course for inclusion in the Northern Michigan University General Education Program. Courses in a component satisfy both the Critical Thinking and the component learning outcomes. Departments should complete this form and submit it electronically through the General Education SHARE site.*

**Course Name and Number: General Chemistry I, CH 111**

**Home Department: Chemistry**

**Department Chair Name and Contact Information** (phone, email): Mark Paulsen (ext 1064, mpaulsen@nmu.edu)

**Expected frequency of Offering of the course** (e.g. every semester, every fall): every semester

**Official Course Status**: Has this course been approved by CUP and Senate? YES

*Courses that have not yet been approved by CUP must be submitted to CUP prior to review by GEC. Note that GEC is able to review courses that are in the process of approval; however, inclusion in the General Education Program is dependent upon Senate and Academic Affairs approval of the course into the overall curriculum.*

**Overview of course** (please attach a current syllabus as well): *Please limit the overview to two pages (not including the syllabus)*

A. Overview of the course content

This course covers, at an introductory level, quantum theory, atomic structure, ionic bonds and compounds, molecular bonding and structure, and chemical reactivity. Students learn about the structure and bonding of ionic and covalent compounds and learn to perform calculations relating to quantities of reagents used and/or products formed, energy changes for chemical reactions, and pressure, volume, temperature, and mole relationships of gases. The laboratory portion of the course is designed to re-enforce the concepts taught in lecture and to teach students laboratory skills. The course consists of 3 hours of lecture, 3 hours of lab, and 1 hour of discussion per week.

B. Explain why this course satisfies the Component specified and significantly addresses both learning outcomes

**Critical Thinking Outcome**

Due to the large numbers of students in CH111 (~300 in Fall 2015), the final exam will be used to assess if students have achieved competency in the critical thinking dimensions. Although students think critically in each component of the course, the final exam is geared primarily toward lecture material and therefore, only examples of critical thinking in the lecture portion of the course are given as examples below.

**Evaluate**

During the lecture portion of the course the students will be presented material and have problem solving modeled for them. During this modeling process the instructor will demonstrate the process of evaluation. Most commonly this would be asking the question after arriving at an answer to a problem, does this answer make sense, or is this answer reasonable? In the laboratory students should constantly be asking themselves as they proceed through the lab, does this result or measurement make sense. In the discussion sections students are typically solving problems and again should always be asking does this solution/answer make sense. A simple example of an evaluation question from an exam would be to give a student a listing of elements and ask which of the elements can undergo valence shell expansion. The student would need to know that only elements with available d-orbitals can undergo valence shell expansion and then evaluate the possibilities for such elements.

**Integrate**

Integration (the connecting of more than one principle or concept) is modeled in lecture on a regular basis. An example of an exam question which requires the students to integrate material is asking them which hydrogen atom in acetic acid behaves as an acid. The students should recognize that there are two different types of hydrogen atoms in acetic acid, and then using the concept of electronegativity determine which hydrogen atom possesses a slight positive charge and hence which hydrogen is the acidic hydrogen atom.

**Evidence**

Students in CH 111 assess the quality of information primarily through the solution of problems on homework, quizzes and exams. During the process of solving these problems, students will be faced with choices which could include which concepts to apply and which pieces of information are required. After solving the problems the students should ask does the answer make sense. In a simple example of how students might assess information, they might be asked to calculate the yield of a product formed during a reaction. They might be given information about the quantities of each reactant and the quantity of solvent. They should evaluate this information and come to the conclusion that only the quantity of the limiting reagent is important and it is this quantity which should be utilized in the determination of the yield of the product.

**Scientific Inquiry Outcome**

The lab portion of the course is the primary area where scientific inquiry is modeled, this constitutes a major portion of the course, 3 hours per week or ~43% of the course time per week. Due to the large number of students in CH111 (~300 in Fall 2015) we will not try to analyze individual lab reports to assess whether or not students have achieved competency in scientific inquiry, instead, we will develop several electronic assignments (via EduCat) specifically designed to assess if students have achieved these competencies.

**Discussion/Conclusions**

For most laboratory experiments students collect data and then at the end are asked to draw some conclusions based upon this data. For example, in a lab titled "CO2 capture" students use the gas laws to evaluate how effective two compounds (monoethanolamine and lithium hydroxide) are at "capturing" carbon dioxide. They use their collected data to draw conclusions as to which compound is the best at "capturing" carbon dioxide.

**Analysis, Results, and Presentation:**

Students are expected to analyze the data using techniques learned in lecture. The analysis and results are summarized in the lab report. For example, in the "CO2 capture" lab, students will use their pressure measurements and the ideal gas law to determine how many moles of carbon dioxide are "captured" by known quantities of monoethanolamine and lithium hydroxide. Students show their calculations (analysis) in the lab report and present their results in the discussion section of their report.

**Methodology/Data Collection:**

In all but one of our labs students do not develop their own methodology, but rather are using a preselected, known methodology to solve a problem or answer a question. It is one of the goals of the course to train students in different chemical techniques (methods) of measurement and analysis which will be useful to them in subsequent chemistry courses. Therefore, we would say we teach and model the methodology dimension. However, in one lab students are given filter paper, a funnel, a hot plate, some beakers, some watch glasses, water, acetone, some tweezers, a magnet, and some spatulas and asked to develop their own method for separating a mixture of sand, pebbles, copper, sodium chloride, iron, and benzoic acid.

**Research Question:**

In none of our labs are students developing a research question, instead students are presented with a purpose for the lab (research question). For example in a lab in which students determine the empirical formula of two compounds, one of the research questions is posed as follows. "In Part 1 of the experiment this week, you will study the reaction of a metal with oxygen (the O2 in the air) to form a metal oxide. Rust is a metal oxide that you are familiar with—it has the formula of Fe2O3. Metal oxides contain metal and oxygen atoms. We will make a metal oxide in the laboratory today and try to determine its formula. Perhaps it is MO, or M2O, or M2O3, or any other combination that you can imagine." Therefore, we would say we model the research question dimension.

C. Describe the target audience (level, student groups, etc.)

The target audience for CH 111 is first year science majors.

D. Give information on other roles this course may serve (e.g. University Requirement, required for a major(s), etc.)

The primary role of CH 111 is to provide students with the basic chemical knowledge and laboratory skills they will need to move on to other science courses, including higher level chemistry courses. It also serves as a course to fulfill the University lab graduation requirement.

E. Provide any other information that may be relevant to the review of the course by GEC

Not applicable.

**PLAN FOR LEARNING OUTCOMES  
CRITICAL THINKING**

*Attainment of the CRITICAL THINKING Learning Outcome is required for courses in this component. There are several dimensions to this learning outcome. Please complete the following Plan for Assessment with information regarding course assignments (type, frequency, importance) that will be used by the department to assess the attainment of students in each of the dimensions of the learning outcome. Type refers to the types of assignments used for assessment such as written work, presentations, etc. Frequency refers to the number of assignments included such as a single paper or multiple papers. Importance refers to the relative emphasis or weight of the assignment to the entire course. For each dimension, please specify the expected success rate for students completing the course that meet the proficiency level and explain your reasoning. Please refer to the Critical Thinking Rubric for more information on student performance/proficiency in this area. Note that courses are expected to meaningfully address all dimensions of the learning outcome.*

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| **DIMENSION** | **WHAT IS BEING ASSESSED** | **PLAN FOR ASSESSMENT** |
| **Evidence** | Assesses quality of information that may be integrated into an argument | **Type:** Final exam.  **Relation to Dimension:** On certain problems on the final exam, students will decide what information to use to solve the problems.  **Success Rate:** We expect ~60% of our students will get these evidence questions correct. |
| **Integrate** | Integrates insight and or reasoning with existing understanding to reach informed conclusions and/or understanding | **Type:** Final exam.  **Relation to Dimension:** On certain problems on the final exam, students will combine skills and knowledge learned from solving problems in lecture and discussion to solving new problems using the same chemical principles.  **Success Rate:** We expect ~60% of our students will get these integration questions correct. |
| **Evaluate** | Evaluates information, ideas, and activities according to established principles and guidelines | **Type:** Final exam.  **Relation to Dimension:** On many problems on the final exam, students will have to evaluate the problem and determine which chemical principles and problem solving methods should be applied.  **Success Rate:** We expect ~65% of our students will get these evaluation questions correct. |

**PLAN FOR LEARNING OUTCOMES  
SCIENTIFIC INQUIRY**

*Attainment of the SCIENTIFIC INQUIRY Learning Outcome is required for courses in this component. There are several dimensions to this learning outcome. Please complete the following Plan for Assessment with information regarding course assignments (type, frequency, importance) that will be used by the department to assess the attainment of students in each of the dimensions of the learning outcome. Type refers to the types of assignments used for assessment such as written work, presentations, etc. Frequency refers to the number of assignments included such as a single paper or multiple papers. Importance refers to the relative emphasis or weight of the assignment to the entire course. For each dimension, please specify the expected success rate for students completing the course that meet the proficiency level and explain your reasoning. Please refer to the Rubric for more information on student performance/proficiency in this learning outcome. Note that courses are expected to meaningfully address all dimensions of the learning outcome.*

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| **DIMENSION** | **WHAT IS BEING ASSESSED** | **PLAN FOR ASSESSMENT** |
| **Research Question** | Develop a manageable and appropriate research question that is tied to testable hypotheses. | **Type:** Several electronic assignments administered at various times throughout the semester.  **Relation to Dimension:** These assignments might consist of a few paragraphs describing an environmental situation, an analysis which must be completed, or some other case study which students must evaluate using learned chemistry concepts. Students will be provided with a list of research questions, and they must choose questions that are appropriate for the described situation.  **Success Rate:** We expect 50% of our students will be able to reach this goal by the end of the semester. |
| **Methodology/Data Collection** | Select and/or develop appropriate scientific methodologies | **Type:** Several electronic assignments administered at various times throughout the semester.  **Relation to Dimension:** These assignments might consist of a few paragraphs describing an environmental situation, an analysis which must be completed, or some other case study which students must evaluate using learned chemistry concepts. Students will be provided with a list of methods, and they must choose methods which are appropriate for the described situation.  **Success Rate:** We expect 55% of our students will be able to reach this goal by the end of the semester. |
| **Analysis, Results and Presentation** | Collected data is appropriately analyzed and presented | **Type:** Several electronic assignments administered at various times throughout the semester.  **Relation to Dimension:** These assignments might consist of a few paragraphs describing an environmental situation, an analysis which must be completed, or some other case study which students must evaluate using learned chemistry concepts. Students will be given data within these case studies and be asked to analyze this data in a manner similar to that which was employed in the performed laboratories.  **Success Rate:** We expect 65% of our students will be able to reach this goal by the end of the semester. |
| **Discussion/Conclusions** | Conclusions are linked to evidence and are in the context of scientific limitations and implications. | **Type:** Several electronic assignments administered at various times throughout the semester.  **Relation to Dimension:** These assignments might consist of a few paragraphs describing an environmental situation, an analysis which must be completed, or some other case study which students must evaluate using learned chemistry concepts. Students will be provided with a list of conclusions which were drawn from the provided data and they must choose which of these conclusions, based upon the given data, are appropriate.  **Success Rate:** We expect 65% of our students will be able to reach this goal by the end of the semester. |