

FY2009 Learning Technologies Grants Proposal
(COVER PAGE)

Project Information

IN-TIME INTERVENTIONS FOR CHEM 1211 AND 1212 USING JEXAM

Project Title

Charles H. Atwood

Project Director

Chemistry

Requesting Department

\$10,000.00

Amount Requested Year 1 (\leq \$15,000)

\$0.00

Amount Requested Year 2 (\leq \$15,000)

Project Director's Signature

Proposal Endorsement Signatures

Department Head

Dean

Proposal Abstract (100-word maximum)

Using previous LTG's, the Chemistry Department built JExam in 2000. In 2004, we added homework functionality to JExam. In 2005, we analyzed student responses to tests and homework using Item Response Theory (IRT). We now know exactly which topics and questions are most critical for student success. We propose to have JExam tell us which students are in danger of failure as soon as they miss a critical topic on either a test or homework. At-risk students identified by JExam will be invited to special intervention sessions led by a chemistry graduate student to improve their success rate.

Section I. Project Description

Freshman Chemistry, CHEM 1211 and 1212, is a large service oriented course which acts as a gatekeeper course for all students interested in pursuing careers in science, medicine, dentistry, pharmacy, or veterinary sciences. These courses are taught to approximately 1800 students per semester. Both courses are taught in a lecture-based format in five sections of 1211 and one of 1212 during fall semester and four sections of 1212 and two of 1211 in spring semester. Tests and homework are delivered to all 1800 students using JExam, a UGA developed computerized testing and homework system.

JExam was built using LTG's beginning in 2000. It has been improved and modernized in the intervening years. In 2004, a homework system was implemented in JExam. In 2005, one of Dr. Atwood's graduate students, Ms. Kimberly Schurmeier, analyzed all of the stored student responses using Item Response Theory (IRT). Based upon her analysis, we have identified those chemistry topics which are the best indicators of student success in CHEM 1211 and 1212. For example, we now understand that students who cannot decode simple chemical formulas are almost certainly destined to fail or withdraw from these courses (topic 2). We have identified a total of 11 such topics which are listed below:

1. Unit conversions
2. Ionic vs. covalent bonds (# of ions generated, strong vs. weak electrolytes, dilute vs. concentrated solutions)
3. Intermolecular vs. intramolecular forces (polar bond vs. polar molecule, Lewis structures, molecular shape)
4. Physical vs. chemical changes and properties
5. Boiling and freezing point vs. boiling point elevation and freezing point depression
6. % dissociation
7. Limiting reactant calculations (mainly understanding excess reactant)
8. Meaning of quantum #'s and connection to electron configuration
9. Lewis acids/bases (electron motion)
10. Moles of reaction in thermodynamics and kinetics
11. Amount of time required for a reaction to reach equilibrium

Based upon a student's performance on their homework or tests, we should have the ability to recognize when that student is struggling with one or more of these topics. Currently JExam does not possess this capability, which because of the number of students in CHEM 1211 and 1212 makes it difficult to identify at risk students. This in turn allows students to carry misconceptions and misunderstandings with them from their homework all the way through their next exam, which reduces their success rate.

In this proposal we are asking for sufficient funds to pay our programmer to develop an algorithm which identifies those students who miss these key topics. Once identified, the system will make a list of the struggling students which we can download. From this list, we will generate a set of e-mails to the students indicating that they need to come to specialized evening help sessions. These sessions will be designed to specifically address those problematic topics which the students exhibited during their homework or test taking. We have already presented this idea to the University's IRB and it has been approved for use starting in Fall Semester 2008.

While JExam has been in use for sometime on campus, it has never had this capability. It is truly an innovation to the system which holds considerable promise in helping students improve in their chemistry skills.

Nature of the Innovation

We will design and build new code to insert into JExam which will identify those students who are struggling with the concepts we know are key to their understanding of chemistry. Once a set of students is identified, we will send them an e-mail informing them (in a polite way) that their presence is requested at a help session especially designed to assist them in understanding this key concept. These help sessions will focus on skills necessary to improve student understanding. These will not be simply an extra class session but a highly focused effort to generate new, deeper understanding of chemical knowledge in students that are deficient in a specific chemical area. We want to emphasize that this is not simply a modernization to JExam but is truly an innovative addition to an existing technology.

Need/Rationale

CHEM 1211 and 1212 are true gatekeeper classes for many students. The Chemistry Department has made a concerted effort to improve these courses and increase student success rates while maintaining high learning standards. For example, in 1997 the withdrawal rate from CHEM 1211 was typically 30%. For the last 8 or 10 years, the withdrawal rate has decreased to 15% due to the Department's efforts. We have also determined from our IRT analysis of the existing question bank in JExam those topics in 1211 and 1212 which are make-or-break concepts for students. It is time for us to use that information to convert at-risk students to successful students. Provided that the students attend the designated help sessions, we have reason to believe that we can make them address the misconceptions and misunderstandings preventing their success in CHEM 1211 and 1212. In this proposal we aim to convert significant numbers of D and F students into C or higher students. We know the historical numbers of students making D's or F's over the last 8 years. In addition, based on our previous IRT analysis we have shown that the student ability level necessary for success in 1211 and 1212 at UGA has not changed in the last 8 years. That work will provide us with an independent measure of the success or failure of this proposal as described below.

Relevance of the Project to Unit and University Priorities

Student success in gatekeeper courses, particularly freshman courses, is not only a University priority but has been highlighted by the Board of Regents. Over the course of the next few years the Board expects withdrawal rates to drop to less than 10% with a concurrent increase in A's, B's, and C's. In this proposal, we are focusing our attention on decreasing the number of students with D and F grades, and increasing the number of students with grades of C or higher. . Many of the University's programs depend upon receiving students who succeed in this course. CHEM 1211 and 1212 students not only go into numerous pre-professional programs but also take subsequent courses in biology, agriculture, forestry, and virtually every other science related field at UGA. Improving our success rate in CHEM 1211 and 1212 will pay dividends throughout the University as these students progress into their major courses.

Specific Courses or Student Groups Benefiting from the Project

CHEM 1211 and 1212 which have ~1800 students per semester.

Number of Students Served, Including Undergraduate, Graduate/Professional or Both

CHEM 1211 and 1212 are large service classes having ~1800 undergraduate students per semester. All of these students complete numerous homework assignments as well as 3 tests on JExam each semester.

Section II. Budget

List technology, facilities, and other resources requested

For this project we need to pay our programmer, Jason Rosenberg, to build the necessary software, test and refine it, support the software, and add necessary upgrades to the software over time.

LTG Budget

Item	Quantity	Total Cost	Requested from LTG	Provided by Other Sources
Programmer services	1	\$10,000	<u>\$10,000</u>	0
TOTALS		<u>\$10,000</u>	<u>\$10,000</u>	<u>0</u>

Budget Justification Narrative

For this project we require the services of Jason Rosenberg, the JExam programmer. He is presently paid \$30,000 per annum for his work. We believe that he will dedicate one third of his time this year to developing this software and any other innovations necessary to identify the at-risk students. Therefore we are requesting \$10,000 from this LTG. One of our graduate students, Mr. Derek Behmke, will gather the information from JExam, craft the e-mails, send them to the students, and develop and administer the specialized help sessions.

Project Timeline

Date (mm/yy)	Objective	Person(s) Responsible
<u>0710/08</u>	Begin software development	Jason Rosenberg
<u>1108/088</u>	Install first version of software into JExam	Jason Rosenberg
<u>0128/098</u>	Test/debug software	Derek Behmke and Jason Rosenberg
<u>0907/09 to 12/09 /08</u>	Initiate project	Derek Behmke
<u>0901/08-09 to 1205/0809</u>	Identify students and hold help sessions	Derek Behmke
<u>0906/08-09 to 1207/0809</u>	Modify and improve software	Jason Rosenberg
<u>12/08 to 01/0907/09 to 12/09</u>	Assess effect of project	Derek Behmke

Section III. Learning Outcomes

Learning Outcomes and How Resources Will Be Used to Achieve Outcomes

Our previous IRT analysis of the JExam database has shown conclusively which chemistry topics determine success or failure in freshman chemistry. All too often the difference between an A and a C or D student lies in their ability to decipher specific

chemical symbols or to recognize the differences between covalent bonds and hydrogen bonds. These are not insurmountable learning objectives. There is no reason why students cannot be warned of their learning deficit, have their specific misconception addressed, learn a proper understanding of the material, and become a successful student. What we require to accomplish this is an early warning system that indicates which students are at-risk. Our software innovation will provide us with that early warning system.

Jason Rosenberg will construct an algorithm which recognizes when and how many times a student has missed one of our key topics. Based upon that information, we will instruct JExam to give us a list of the students who have missed the topic. Derek Behmke will then e-mail that list of students indicating when and where a specialized help session will be conducted to help them address their misconception. Derek will design a set of activities to use in the help session which will help the students attain a deeper and fuller understanding of the key topic. During the help session, several in-session assessments will be provided to determine each student's progress in understanding the topic.

Provided that the students take heed of the notices and attend the help sessions, significant improvements in student understanding will occur on those key topics necessary to succeed in CHEM 1211 and 1212. Our primary expected outcome is an improvement in the numbers of students making A's, B's, or C's with a decrease in the number of the D and F students.

Methods for Evaluating the Project and Learning Outcomes

In the [fall-spring](#) semester of [20082009](#), we will initiate this project in all sections of CHEM 1211. We have statistical data on the CHEM 1211 and 1212 student abilities for the last 8 years. Furthermore, our D and F percentage has remained a constant 6% F's and 12% D's for the last five years. We can readily predict from their performance on homework which students are at-risk for failure in these classes. Based on these statistical benchmarks, we can detect any change in the student performance attributable to this project.

All of our work has been approved by the University's IRB and we have already indicated to the Review Board that we intend to institute this project. Derek will capture the names of every student who misses one of our key topics on a homework or exam. He will also track those students that attend the help sessions. Based upon that information he can perform statistical analyses (including Classical Test Theory, Item Response Theory, t-tests, differential item analysis, and other valid analyses) to ferret out the effects of our intervention. We predict that the net result will be a measurable improvement in these students' performance in CHEM 1211 this fall semester.

Potential Applications in Other Academic Areas

It is certainly possible to do similar analyses in other academic areas, in particular UGA's large biology and psychology classes, which depend upon key concepts or topics for student success. While neither of these classes presently use JExam, the basic idea is feasible in whatever format their testing is performed.