COLLEGE OF NATURAL AND APPLIED SCIENCES
CHEMISTRY
BACHELOR OF ARTS IN CHEMISTRY
MINOR IN CHEMISTRY
THREE FULL-TIME FACULTY MEMBERS

I. CHEMISTRY CURRICULAR MAPPINGS (CMs)

CHEMISTRY DEGREE PROGRAM SLOs

CH PROGRAM GOAL-1: Demonstrate the knowledge of fundamental concepts of chemistry and its relevance to the scientific method and other fields in science with the following objectives:

- **CH PR-11**: Students should be able to explain the scientific method and relate its application to chemical discoveries.
- **CH PR-12**: Students will be able to define the states and structure of matter and relate these to physical and chemical properties.
- **CH PR-13**: Students should be able to define chemistry and state its relevance to other sciences and everyday experience.
- **CH PR-14**: Students should be able to apply the fundamental concepts of elements and compounds and their reactivity to solve chemically based problems

CH PROGRAM GOAL-2: Demonstrate the skills to make observations, experimentation, collect and collate data, analyze and interpret data in a safe chemical environment with the following objectives:

- **CH PR 21**: Students will be able to independently perform accurate quantitative measurements, interpret experimental results, perform calculations on these results and draw a reasonable, accurate conclusion .
- **CH PR-22**: Students will synthesize, isolate, purify and characterize a series of compounds using modern methods.
- **CH PR-23**: Students will demonstrate knowledge of proper use of modern instrumental techniques.
- **CH PR-24**: Students will be able to design an experimental procedure.
- **CH PR-25**: Students will observe safe practices in the laboratory and will know how to respond in an emergency. Students will learn to gather hazardous materials information and will recognize and respond properly to potential hazards of handling chemicals and chemical waste.

CH PROGRAM GOAL-3: Demonstrate the ability to clearly articulate, formulate, and communicate scientific information using computer, written and oral communication skills with the following objectives:

- **CH PR-31**: Students will communicate critical analysis of scientific information through written reports and laboratory notebooks.
- **CH PR-32**: Students will effectively communicate scientific information through oral presentations.
- **CH PR-33**: Students will use computer technology to gather, process, analyze, and present chemical data.
- **CH PR-34**: Students will use chemical literature and computer resources to gather research information.

CH PROGRAM GOAL-4: Demonstrate critical thinking, problem solving skills and the ability to use chemical knowledge and mathematical skills to identify, evaluate, analyze, synthesize, and integrate data and abstract ideas in solving problems with the following objectives:

- **CH PR-41**: Students should be able to describe the structure & composition of matter.
- **CH PR-42**: Students should be able to solve qualitative & quantitative problems.
- **CH PR-43**: Students should be able to apply theoretical and mechanistic principles to the study of chemical systems using quantitative and qualitative approaches.
- **CH PR-44**: Students should be able to explain the role of energy in determining the structure and reactivity of matter.
- **CH PR-45**: Students should be able to apply theoretical knowledge and chemical information to industry and everyday experience.

CH PROGRAM GOAL-5: Demonstrate the knowledge and skills in advanced instrumentation, applications, interpretation, and experimental design to address scientific queries in chemistry, industry, the environment, health, and related fields with the following objectives:

- **CH PR-51**: Students should be able to use modern analytical instrumentations.
- **CH PR-52**: Students should be able to interpret data and relate these to chemical structure and properties.
- **CH PR-53**: Students should be able to relate the application of instrumentation to industries.
- **CH PR-54**: Students should be able to develop an appreciation of the wide range of instrumental methods, their applications, and limitations.

CH PROGRAM GOAL-6: Demonstrate a sense of exploration and research approach that enables students to pursue lifelong learning in chemistry with the following objectives:

- **CH PR-61**: Students will use chemical literature and computer resources to gather research information.
- **CH PR-62:** Students should be able to critically evaluate scientific information.
- **CH PR-63**: Students should be able to develop research project & design experimental approach.

CH PROGRAM GOAL-7: Demonstrate interaction skills and teamwork with the following objectives:

- **CH PR-71**: Students should be able to work cooperatively in problem solving exercise.
- **CH PR-72**: Students should be able to exercise leadership skills in teamwork.
- **CH PR-73**: Students should demonstrate adequate interpersonal communication skills.

CHEMISTRY DEGREE PROGRAM CM

COURSE NO.	LINK TO PROGRAM SLOs[1]																												
	CH PR-11	CH PR-12	CH PR-13	CH PR-14	CH PR-21	CH PR-22	CH PR-23	CH PR-24	CH PR-25	CH PR-31	CH PR-32	CH PR-33	CH PR-34	CH PR-41	CH PR-42	CH PR-43	CH PR-44	CH PR-45	CH PR-51	CH PR-52	CH PR-53	CH PR-54	CH PR-61	CH PR-62	CH PR-63	CH PR-71	CH PR-72	CH PR-73
CH 100	1,7	3	1,7	2,4, 5						6				3	2	1										7		7
CH 100L	3	2	3	2,4	2				1	3						4										6		6
CH 101	1	3	5	1,2, 3,6						7	7			1	2	3, 6		5										
CH 101L	2	3	3	2,5	2				1	4,5	5	5				3										7		7
CH 102										8					2	4	4,5, 6	9										
CH 102L					2				1	6	7	7				4										8		8
CH 103										4	4,6	4,6			2	3										8		8
CH 103L					2				2	6,7, 9	6,7	7				4												
CH 310a										7			9	1	4	5				6			9					
CH 310b										7	7	7	9	1	4	5				6			9					
CH 311					2	3			1	4						6				7						6		6
CH 312					2	2	3		1	10	10	10	11		5	8				6			11			9		9
CH 330										8				4	1,2, 4,5	1,2, 5		3		4			7			6		6
CH330L					2	3	2		1	4	4	7			3					2			5			5		5
CH392					2	3	2		1	8					6, 9											10	11, 12	10
CH410										7	7			1,5	1,2, 3,4	5	5		2,3, 4	5	10	2	6	8				
CH410L					2	3	2		1	6	6	6	5	1	5	5		10					5	7				
CH450														1	3		4	5,8					7	3				
CH451L					2	3	2		1						3	1		6							6			
CH491										2,7	4	3	1,2	6	1, 6			1,2, 7								7		7

CHEMISTRY/NURSING SUPPORT PROGRAM SLOs

- **CH NU-1**: Students should be able to explain the scientific method and relate its application to chemical discoveries.
- **CH NU-2**: Students will be able to define the states and structure of matter and relate these to physical and chemical properties
- **CH NU-3**: Students should be able to define chemistry and state its relevance to other sciences and everyday experience.
- **CH NU-4**: Students should be able to apply the fundamental concepts of elements and compounds and their reactivity to solve chemically based problems
- **CH NU**-5: Students should be able to solve quantitative and qualitative chemically based problems
- **CH NU-6**: Students should be able to communicate clearly through written and oral format
- **CH NU-7**: Students should be able to conduct safe laboratory experiments and obtain results
- **CH NU-8: S**tudents should be able to synthesize and analyze chemical data.

GE SCIENCE SLOs

- **SC GE-1**: observe, describe, and interpret natural and experimental phenomena within the context of a scientific paradigm;
- **SC GE-2**: develop and employ skills of logical and critical thinking to collect and analyze data, interpret results, and write reports;
- **SC GE-3**: characterize scientific knowledge as theories and principles that result from experimentation that are subject to revision based on new observations and discoveries;
- **SC GE-4**: apply basic scientific principles and methods to explore the workings of the natural world, particularly in this region;
- **SC GE-5**: apply basic scientific principles and methods to solve real-world problems, and make appropriate use of science in their choices as citizens.
- **SC GE-6**: identify the capabilities and limitations of science, and distinguish science from pseudoscience;
- **SC GE-7**: identify how scientific ideas and values have been integrated into society and how other aspects of society affect science as a human activity.

CHEMISTRY/NURSING SUPPORT PROGRAM CM

COURSE NO.	LINK TO CH/NU SLOs[1]							
	CH NU-1	CH NU-2	CH NU-3	CH NU-4	CH NU-5	C H NU-6	CH NU-7	CH NU-8
CH100	1	2	7	3,5	4,5	6		
CH100L						3	1,2	2,4,5
CH101	1	3,4,5		6	1,2	7		
CH101L				3		7	1	2

CHEMISTRY GE CM

COURSE NO.	LINK TO GE SLOs[1]						
	SC GE-1	SC GE-2	SC GE-3	SC GE-4	SC GE-5	SC GE-6	SC GE-7
CH 100	1,2	1,2,3	1,2,3	7			7,8
CH 100L	1,2	3		5	6		
CH 101	1,2	1,2,3	2,3	4	2		7
CH 101L	1,2	3,5			5		7

[1]The numbers are course SLO numbers that link the course to the program SLO (See UOG/CNAS/CNAS Assessment Website for detailed descriptions of these course SLOs by visiting: http://www.uog.edu/dynamicdata/CNASAssessment.aspx?siteid=2&p=20);

II. CHEMISTRY PROGRAM ASSESSMENTS

ASSESSMENT ACTIVITY	ASSESSMENT RESULTS AND RECOMMENDATIONS FOR PROGRAM IMPROVEMENTS
1. CH102 and CH103: Pre- and Post test; Normal Test analysis using a rubric adapted to assess the quantitative skills.	Assessment results show students difficulty in integrating two or more concepts for solving quantitative problems. We emphasize on quizzes as one area to re-enforce their learning skills. The frequency of spot quizzes was increased together with its weighting in the overall assessment. Test results from Fall 2008 show some marked improvement in student overall performance. Student participation in class has also increased as these problem solving exercises are discussed. Exam were also split to two parts (mid-term and end of semester final) to enable students to prepare well.
2. CH100, CH102, CH103, CH310 Laboratories. Assessment rubrics for some laboratory exercises and in the laboratory practical exam were issued before the task	Students had a very clear expectation under the categories listed. The level of competence in conducting experimental exercise was better. The supervision effort was less demanding for the faculty. However the calculation based on theoretical quantitative problems show some deficiencies. A similar approach based increase emphasis on spot quizzes is currently tested.
3. Chemistry Program student learning outcomes	All chemistry courses student learning outcomes have been revised. The involvement of all faculty members has helped in identifying the major focus of the assessment activity.
4. Chemistry Program assessment seminar	Chemistry faculty presented results of assessment to the college. Some feed back on data analysis and interpretation was considered for improvement.
5. Chemistry Program Goals	The program goals have been revised and linked to the SLO and is presently used for assessment and course revision.
6. Chemistry Student Seminar Introduced to two courses	One area that became obviously lacking from the revised SLO was on the communication and research skills. Student's seminar presentation was included in two courses and is currently monitored.
7. CH101 and CH101L A 4 credit course with lecture and lab	This course was separated to 3 + 1 credit hours to clearly project the laboratory and lecture components. Faculty teaching load are clearly defined and less confusion on students for class timetable
8. American Chemical Society standardized exam	These exams have been used in some of our courses for a number of years. Data analyses on the results show some high and low performance which was attributed to the cohort of students at those periods. The overall results compares well to the national average.

III. CHEMISTRY PRE- AND POST-TESTS ASSESSMENT STUDIES

ASSESSMENT ACTIVITY

The chemistry department assessment was drawn from the program objectives that were presented as the Chemistry Program Assessment plan in 2007 (For details on these program objectives, go back to the SLOs/CMs icon in this website).

1. The following goal/objective was selected for assessment:
   Goal #4: : *Demonstrate critical thinking, problem solving skills and the ability to use chemical knowledge and mathematical skills to identify, evaluate, analyze, synthesize, and integrate data and abstract ideas in solving problems.*
   Objective #2: *Students should be able to solve qualitative & quantitative problems.*

2. Assessment Methods Selected for Assessment:
   a. Pre- and post-test (For multiple section courses, the same pre- and post test was used. Drs. Balakrishnan and Vuki conducted pre- and post-test for CH100, CH102, and CH103. Dr. Suleman conducted pre- and post-test for CH310a and CH310b);
   b. Analysis of specific questions that deals with quantitative skills from the normal exam (This method saves the effort of preparing a separate set of questions, but it involves keeping copies of the exam scripts to carry out data analysis);
   c. Giving embedded questions in a normal exam (This method is currently being conducted and no data is available but the results from the two methods stated are reported in this updated assessment report).
   d. American Chemical Society Standard Exam

3. Chemistry Quantitative Skills Assessment Rubrics Used

	Student preparation level	**Insufficient**	**Fair**	**good**	**Very good**	**excellent**
	Types of quantitative skills	1	2	3	4	5
A	Data collection, organization and recognition	Mostly wrong, major mistakes, no organization or understanding data	Some correct, several major mistakes, unorganized, limited understanding	Minimum acceptable work, many minor mistakes, some understanding	Adequate level of work, could be improved, several minor mistakes, good level of understanding	Exemplary work, well organized, excellent understanding
B	Calculations skills using basic formula	Mostly wrong, major mistakes, no organization or understanding data	Some correct, several major mistakes, unorganized, limited understanding	Minimum acceptable work, many minor mistakes, some understanding	Adequate level of work, could be improved, several minor mistakes, good level of understanding	Exemplary work, well organized, excellent understanding
C	Calculation with complex equation, solving complex algebra	Mostly wrong, major mistakes, no organization or understanding data	Some correct, several major mistakes, unorganized, limited understanding	Minimum acceptable work, many minor mistakes, some understanding	Adequate level of work, could be improved, several minor mistakes, good level of understanding	Exemplary work, well organized, excellent understanding
D	Interpretation of data, numbers, chemical concepts	Mostly wrong, major mistakes, no organization or understanding data	Some correct, several major mistakes, unorganized, limited understanding	Minimum acceptable work, many minor mistakes, some understanding	Adequate level of work, could be improved, several minor mistakes, good level of understanding	Exemplary work, well organized, excellent understanding

ASSESSMENT RESULTS AND RECOMMENDATIONS

1. Summary of Assessment Results (See below)

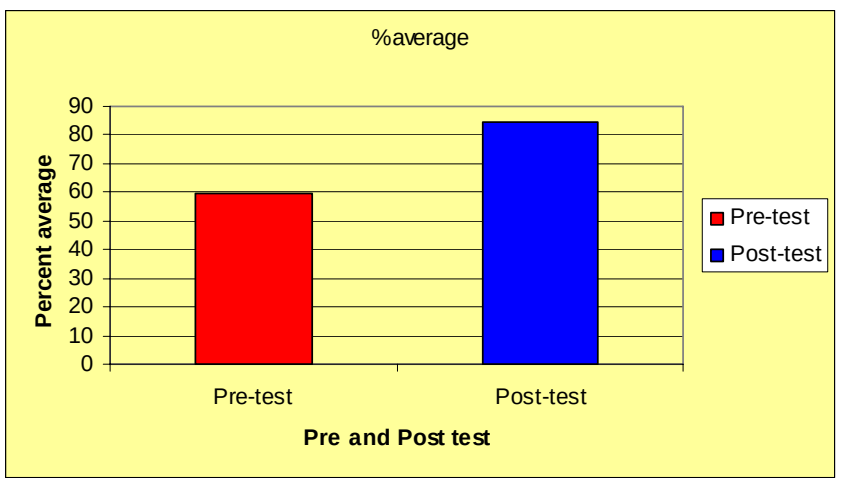
2. Recommendations for Improvements

a. Emphasize key problems that involve synthesis if information in the course reviews and give more worked out examples;
b. Review syllabus and identify where more emphasis is needed;
c. Give regular quizzes to engage student on the level of requirement;
d. Split final exams into two sections. One to be administered in the middle of semester covering the completed topics and the second at the end of semester that will cover the rest of topics;
e. Conduct assessment with American Chemical Society Standard Exams;
f. Record Review sessions on video or DVD so that students can review at their own pace and hence spend more time in understanding the concepts;
g. Set up a resource center that student could access help, books, tutors, software;
h. Refine the test questions for assessment and conduct assessment.

IV. ASSESSMENT RESULTS

1. The results from the pre- and post-exams for CH100 FALL 2007

a. Figure 1.0. Average score for the CH100 student at pre-test and post-test for CH100, Fall 2007:



The results show a general improvement on student's performance. However, the level of improvement is not so significant considering that many of them show adequate level of subject knowledge from the pre-test results of about 60%.

b. The same set of results from Figure 1.0 was analyzed under the assessment rubric. Since the focus of the assessment was quantitative skills, a selection of quantitative questions from the test was identified and applied under the rubrics. The results are as plotted in Figure 2.0.

Figure 2.0. Pre and Post Test analysis for CH100 under the assessment rubric, Fall 2007. Plot of difficulty factor as a function of learning categories.

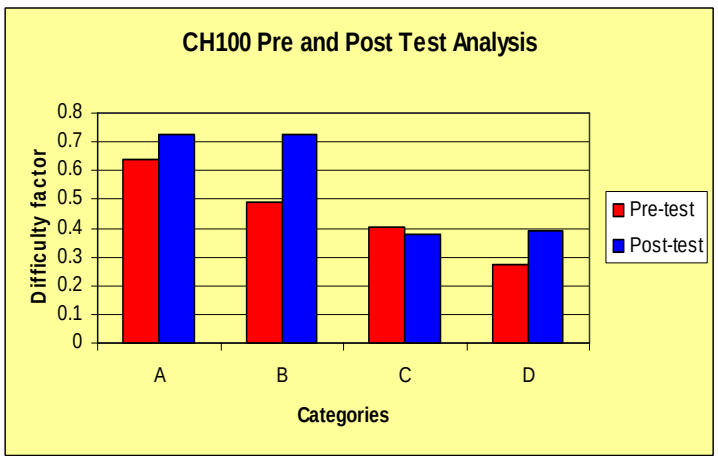


Figure 2.0 clearly show that students performed better under categories A and B compared to categories C and D. While post test appears to show slight improvement under categories A, B, and D there was no clear improvement under C. Overall the results clearly show the low score under categories C and D. This conforms some of our initial assumption that students have difficulty in integrating several key concepts to arrive at the final answer.

The difficulty factor is the ratio of students who scored the correct answer in a particular question over to the total number of students. High difficulty factor scores indicate that students have better understanding and skills for solving the problem.

2. The results from the pre- and post-exams for CH102 FALL 2007

a. Figure 3.0. Average scores for the pre- and post test for CH102 students

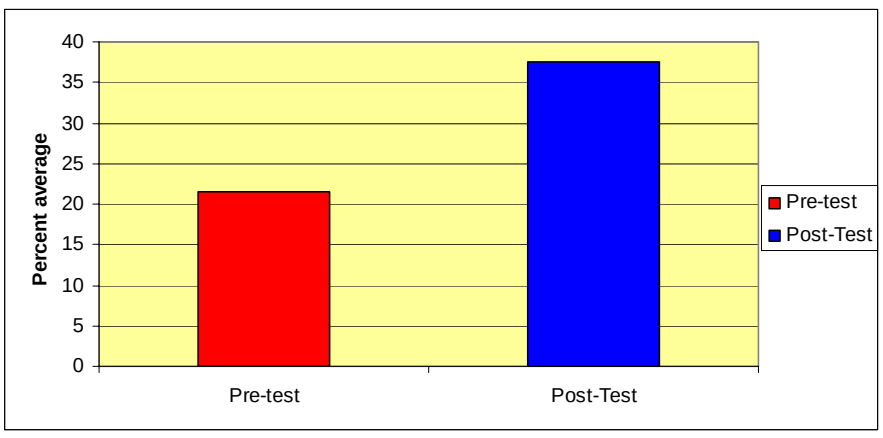
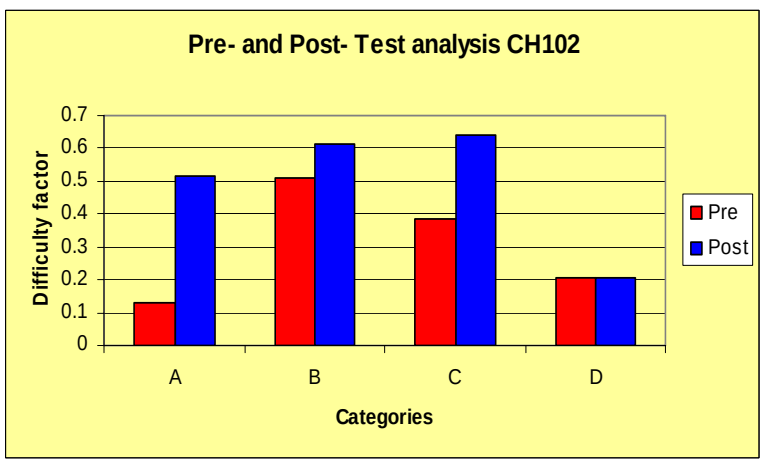


Figure 3.0 show improvement in the average scores from pre-test to post-test. However, what is obvious is the low percentage in both tests. While this datum does not present a very promising learning outcome, it provides an important lesson to the assessment approach. When these tests are not considered to be part of the student's final grade, the tendency is for students to guess or ignore the outcome. As a result, the scores show very low overall scores.

b. Figure 4.0 show the analysis of specific questions using the assessment rubrics. The plot shows remarkable improvement for category A but not as high for categories B and C. Category D show no improvement and overall score is also very low.

Figure 4.0. Pre and Post Test analysis for CH102 under the assessment rubric. Plot of difficulty factor as a function of learning categories.



3. RESULT for the CH102 Pre- and Post Test FALL 2008

Figure 5.0. Average score from the Pre- and Post-test results for CH102 in Fall 2008
Results show improvement in the Post exam, similar to the Fall 2007. The percentage average is still low. This may be due to the fact that the exam was not included in the course assessment.

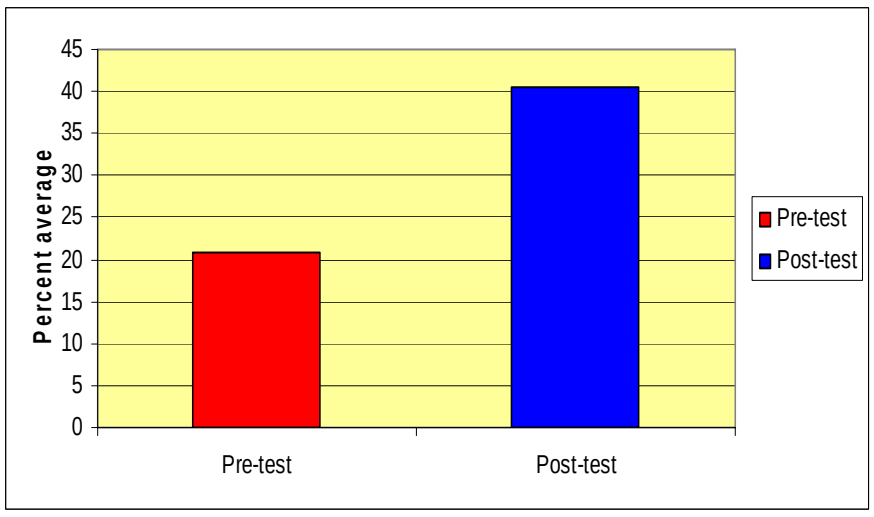
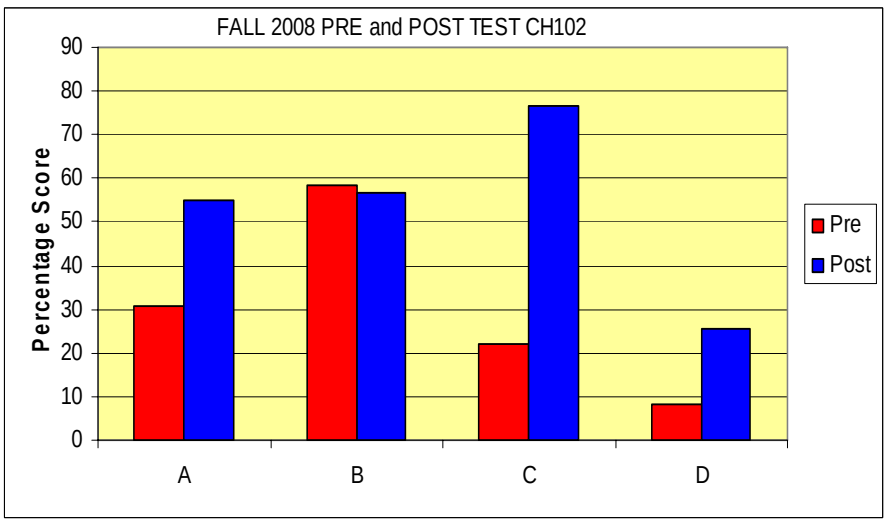
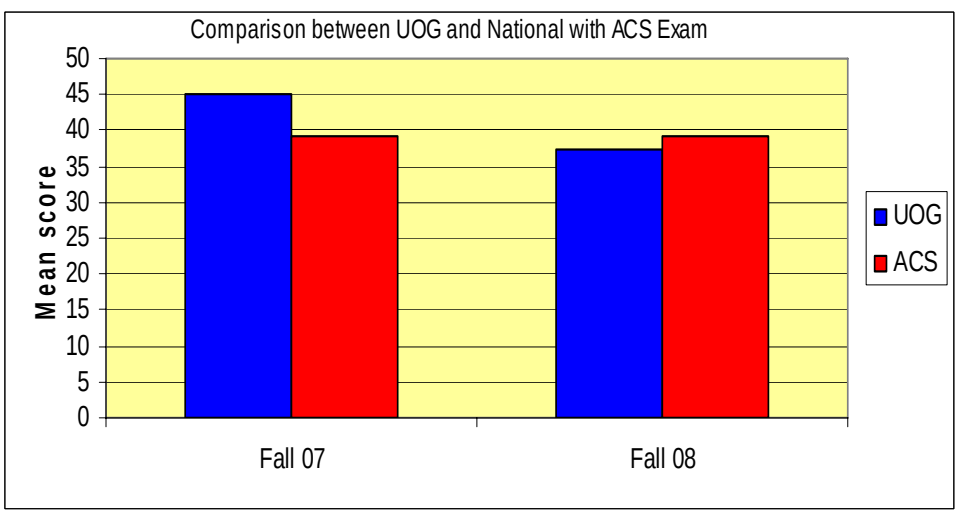


Figure 6.0
Plot shows the Pre- and Post- test analysis using the assessment rubric for Fall 2008. Post test results for category A and B compares well with Fall 2007. However, a significant improvement occurred in the post test result in category C. This could be due to the increased spot quizzes that were introduced after the Fall 2007 results.



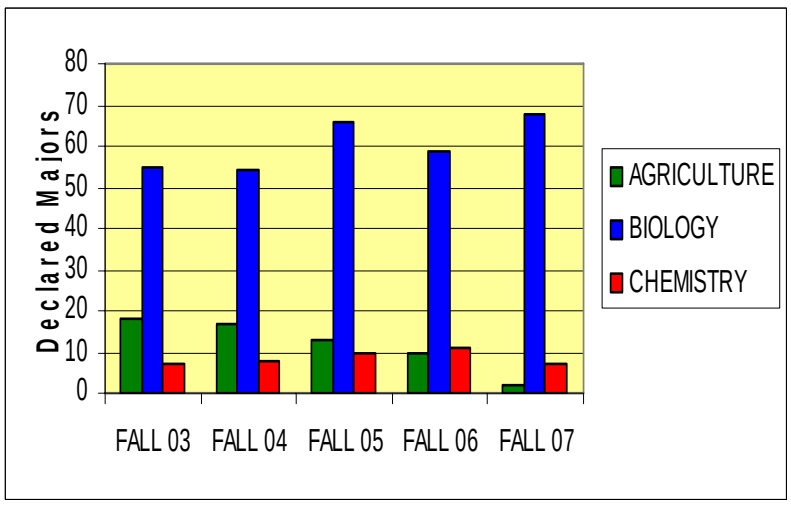
4. Comparison between the UOG results with the American Chemical Society National Exam for Fall 2007 and Fall 2008

Figure 7.0
Plot showing the average scores of the UOG students and the National average on the American Chemical Society National Exam.
Results shows that the performance of the UOG students compares very well with the ACS results. The higher average for UOG in Fall 2007 was attributed to a number of very talented students that year.



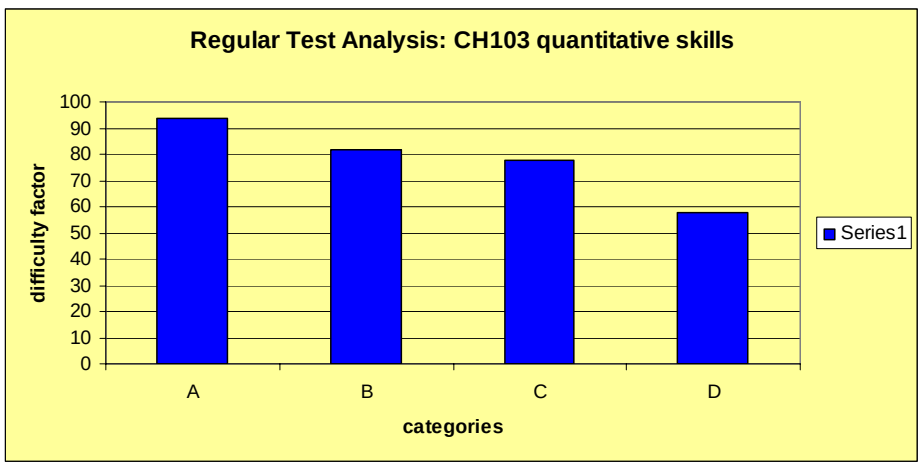
5. Declared Majors and Credit hour production

Figure 8.0
Plot showing the trend for declared majors for Chemistry Program in comparison with Biology and Agriculture. Chemistry has remained below 10 for most years.



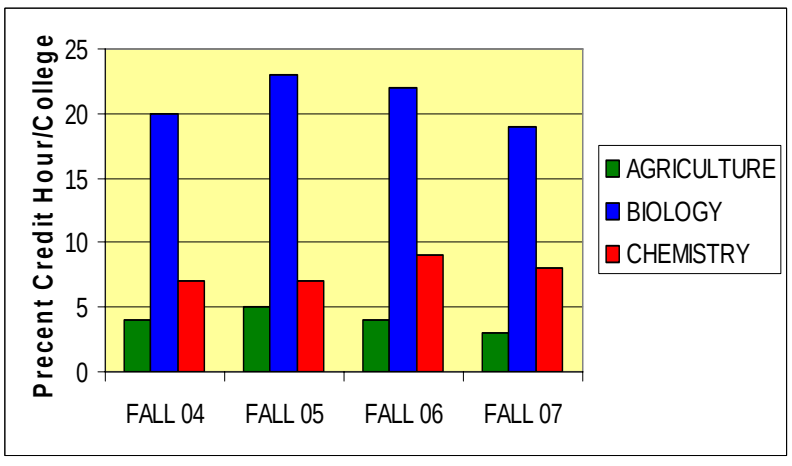
6.0 Regular Test Analysis for CH103

Figure 9.0
A regular exam data analyzed using the same assessment rubric. The scores were higher than the Pre- and Post-Test but they both show the same trend. Category A is the highest while category D shows the lowest score.



7.0 Credit hour Production

Figure 10.
Plot showing the trend in Credit Hour production for Chemistry Program in comparison with Biology and Agriculture.



6. Results from analysis of normal exam in the CH103

Results from analysis of normal exam in the CH103 course also show similar trends to what is shown from the CH100 and CH102 results. The students generally have low score for category D. In summary, the students generally score better in the post exam which does indicate the gaining of skills. However, the level of gain students may not be very conclusive due to the uncertainty in our methodology. Students also show difficulty in integrating and synthesizing information to solve problems. This could be due to several factors and the department will further look into some issues such as entry level of our students, content of our courses, and our delivery methods. However, based on these finding we are able to identify some key areas that could be improved in our courses (See Recommendation for Improvements in Section III above).