Department of Chemistry
Assessment of Undergraduate Majors
who graduated between May & Dec 2002

prepared by Mark A. Griep
Chemistry Undergraduate Assessment Czar
with input from the Chemistry Department faculty
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How has the assessment plan been conducted?

This is the fourth consecutive year that the Chemistry Department assessed its graduating seniors using its March 1999 procedure. The direct assessment method is the ETS Majors Assessment Exam in Chemistry (a 2-hour exam that covers analytical, inorganic, organic, and physical chemistry). The other method is an exit interview conducted by the Chair. The interviews were not summarized this year. This will allow their numbers to increase and to give statistical significance to their analysis next year.

Assessment Results and Discussion

A. Analysis of the Standardized Exam Results (2002)

1. Statistical Validity & Overall performance on the Standardized Exam

Six graduating seniors took the standardized exam this year (5 BS, 1 BA). One part-time student never responded to my email or mail contacts and did not take the exam. The student lives in Omaha and commutes to UNL.

Before the exam, the students were told they would earn scholarships of $2 for every percentile over 50% of their total percentile ranking. The average overall percentile score for this year's graduating seniors was 79%, which means the department paid the students $352 in scholarships. This scholarship was created to encourage students to do their best on the exam. One of the reasons for doing this was that some students chose not to answer certain questions and their overall very low percentile rankings were skewing the results for reasons that did relate to their ability but did relate to their level of motivation.

The average total percentile ranking of this year's six students was 79%. This was the same as the average ranking for the 18 students from the previous three years (when the three students who had not answered questions were excluded); that is, 79%. The scholarships seem to have achieved the intended result of motivating them to answer as many questions as possible.

The distribution plot of our majors' performance on the ETS Chemistry Majors Exam (Figure 1) indicates that this year's class was about the same as previous years'.

Figure 1: Percentile Range Distribution

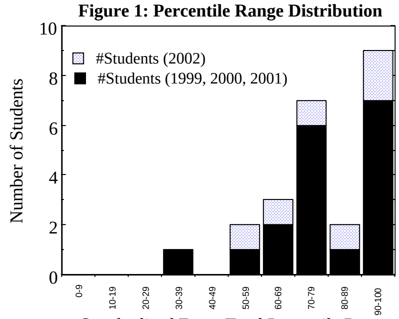
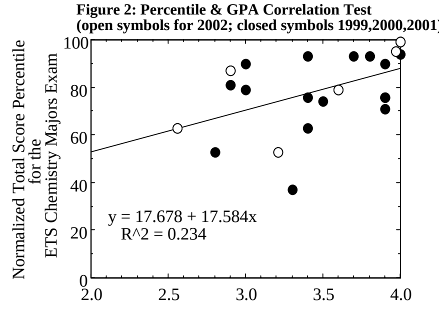


Figure 2: Percentile & GPA Correlation Test
(open symbols for 2002; closed symbols 1999,2000,2001)



2. <u>Relationship between Cumulative GPA and Percentile Ranking on the Standardized Exam</u>

To determine whether and how our majors' performance correlated to the Standardized Exam, I plotted the Majors Exam total percentile ranking versus cumulative grade point average (Figure 2). Grades of A+ were counted as being equal to 4.5. A least-squares fit to the data showed a poor correlation. The UNL cumulative grade point average provides only a rough prediction of student's performance on the ETS Chemistry Majors Exam.

3. <u>Relationship between Chemistry GPAs and Exam Percentile Rank and UNL GPA</u>

Last year, one of the questions from the faculty was whether there would be a better correlation between a student's Chemistry GPA and their overall percentile ranking. A plot of this year's class Chemistry GPAs (lecture courses only) versus Total Percentile Ranking (Figure 3) revealed that there was a modest correlation but that it might not be better than overall UNL GPA. To demonstrate that principle, I plotted Chemistry GPA versus UNL GPA and found an excellent correlation between the two values (Figure 4). The slope of the plot indicates that it is about 11% harder to earn a good GPA in Chemistry than within UNL as a whole. (I apologize that the chemistry GPAs rise above 4.0 but I calculated the chemistry GPAs using A+ as being equal to 4.5).

The plot of chemistry GPA vs. UNL GPA also indicates that chemistry students are excellent scholars.

Figure 3: Chemistry GPA vs. Overall %ile Rank

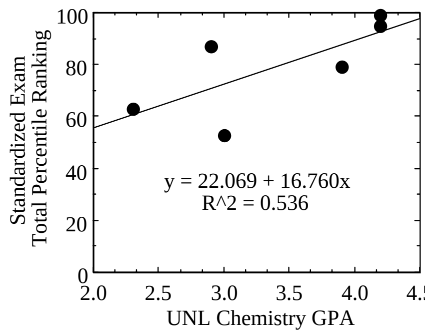
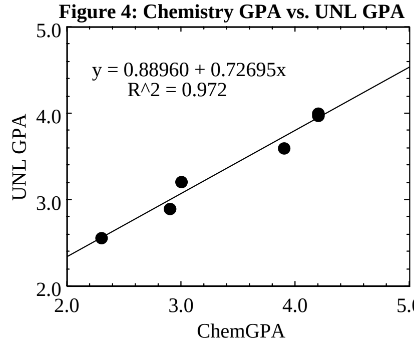


Figure 4: Chemistry GPA vs. UNL GPA



4. <u>Performance on the Subfields</u>

The ETS Chemistry Majors Exam scored and determined the percentile rankings for the subfields of Analytical, Inorganic, Organic, and Physical Chemistry. To determine how well our students performed in the various subfields, I made a table of student performance (Table 1). This year's students are represented with a **bold "x"**. Looking at those scores above the 80th percentile, students performed best on the physical subfield followed closely by analytical, then inorganic and finally organic. Looking at the percentiles below 50%, the largest numbers of students are in the organic and inorganic subfields.

Table 1: Distribution of Subfield Percentile Ranges (2002 percentiles are bold)

	Number of Students in Each Percentile Range			
Subfield Percentile Range	Analytical	Inorganic	Organic	Physical
90-100	xxxxx**xxx**	xxx**x**	xxx**xx**	xxxxx**x**
80-89	xxxx**x**	xxx**xx**	xxxx	xxxxx**xxxx**
70-79	xxxx**x**	xxxxxxxx	xxxx**x**	xxxxx
60-69	x	x**x**	xx**xx**	x**x**
50-59	xxxx**x**	x	xx	xx
40-49	x	xx**x**	xx	xx
30-39	x	x	x	
20-29	x	**x**		x
10-19	x	x	xxx**x**	
0-9		x		x

5. <u>Correlation between Subfield and Student's Research Area</u>

The correlation between the student's research area and subfield performance was assessed by noting all percentiles above the 80th percentile (Table 2) or the highest percentiles if none were above 80%. The same trends that were observed last year still hold.

- •Nearly all students who do Analytical Chemistry research perform best in the physical chemistry subfield.
- •Organic students perform well in the Organic and/or Inorganic subfields.

There are now five Physical students who have taken the Standardized Exam. Most of them performed best on the physical subfield and three of them performed well on the analytical subfield. There is a strong positive correlation between a student's research and how well they do on the subfield section of the Standardized exam in their chosen area. Either their research experience has enhanced their performance on the standardizes exam or they choose a research experience that represents their strength.

Table 2: Relationship between Research Area and Best Subfield Performance **(this year's students in bold)**

Student's Research Area	Highest Percentile Scores
Analytical	99% analytical, 98% physical, 97% organic, 86% inorganic
Analytical	96% physical, 90% analytical, 90% inorganic
Analytical	96% physical
Analytical (2002)	**91% physical, 82% inorganic, 81% analytical**
Analytical (2002)	**83% physical**
Analytical	81% analytical
Analytical	69% physical
Analytical	51% physical
Organic (2002)	**99% organic, 94% analytical, 88% physical, 82% inorganic**
Organic	96% inorganic, 93% analytical, 82% physical
Organic	96% physical, 86% analytical, 82% organic, 80% inorganic
Organic	94% analytical, 87% organic, 86% inorganic, 83% physical
Organic	91% organic
Organic	91% physical
Organic	90% inorganic, 88% physical
Organic	87% organic
Organic	79% inorganic
Physical	99% organic, 90% analytical, 88% physical
Physical (2002)	**91% analytical**
Physical	83% physical, 81% analytical
Physical (2002)	**83% physical**
Physical	76% physical

The following students are in the BA program that does not require students to perform undergraduate research

none (2002)	**99% organic, 99% inorganic, 98% analytical, 88% physical**
none	82% organic
none	56% analytical

6. Comparison of student performance with whether they take Inorganic or Analytical courses

Because of our "2 out of 3 option", students can choose between Analytical Chemistry, Biochemistry, or Inorganic Chemistry. The majority of them choose to take Biochemistry and one of the other two. Since the standardized exam tests students on their ability in Analytical and Inorganic Chemistry, we can determine the effect of taking those courses with those students who do not take those courses (Table 3). In both subfields, about half the top performers (defined as better than 80th percentile) had not taken a UNL Chemistry course in that area.

Ironically, the students who perform the best on these subfields did not take either of these courses. These standardized exams must test for material that the students are picking up in other courses such as general chemistry, organic chemistry, and physical chemistry.

Table 3: Relationship between Subfield performance and whether or not student took UNL course

Percentile in the **IChem** subfield	grade in 441	Percentile in the **Achem** subfield	grade in 421
99	**did not take**	99	did not take
90	did not take	**98**	**did not take**
86	transfer	94	did not take
86	4.00	**94**	**4.00**
82	**did not take**	**91**	**did not take**
82	**4.50**	86	4.00
80	3.00	**81**	**3.67**
79	did not take	81	did not take
73	4.50	81	4.00
73	did not take	74	4.50
73	4.00	74	4.00
69	**4.00**	74	2.00
44	**did not take**	**74**	**did not take**
43	did not take	56	did not take
43	did not take	**56**	**4.00**
32	2.00	56	3.50
26	**did not take**	47	4.00
21	did not take	27	3.00

May 10 Addendum to 2002 UG Assessment by Mark Griep

7. Student performance on the Analytical Chemistry Subfield and in Analytical Chemistry courses

It was noted in previous years that student performance on the Analytical Chemistry subfield portion of the standardized exam does not correlate very well with performance in CHEM 421. In fact, many students who did not take CHEM 421 did very well on the Analytical subfield portion of the exam. This year, a faculty member proposed that CHEM 116 performance for BS majors and CHEM 221 for BA majors was the appropriate course to use for comparison. An analysis of student grades bears this out. There is an excellent correlation between grades in these courses and performance on the Analytical subfield.

Since the grades for students in those courses are available, I have made a new table (Table 5) that shows the relationship between the Analytical Chemistry subfield percentile and student grades in the three Analytical Chemistry courses. CHEM 116 is for students who were BS-track freshman. CHEM 221 is for those students who were on the BA-track or who entered the program later with a deficiency. The data is for students from 2000, 2001, and 2002 whose folders I still retain. Once again, a grade of A+ was translated to 4.5.

This new table shows that there is a good correlation between student performance in CHEM 116 and student percentile score in the Analytical Subfield of the Standardized Exam. The correlation is much better than it is for CHEM 421, which they would have taken much closer to the time of the exam. This data may also suggest that the material in CHEM 116 (and 221) is more similar to the material on the Analytical portion of the Standardized Exam.

This analysis raises a different issue. The data for the Analytical Chemistry subfield suggest that student performance as freshman was a very good predictor of performance on this part of the standardized exam. The reason could be that chemistry students choose chemistry because they are good at analytical chemistry. Or, it could be that the tools that students learn in freshman analytical chemistry are reinforced in all subsequent courses and training. It could also be both. I bring this up because, last year, one explanation for the relatively lower percentile rankings in the Organic subfield (Table 1) was that students had encountered the material two years before the exam and had plenty of time to forget it. Perhaps a better explanation for the poor showing in Organic chemistry is a lack of reinforcement in subsequent courses.

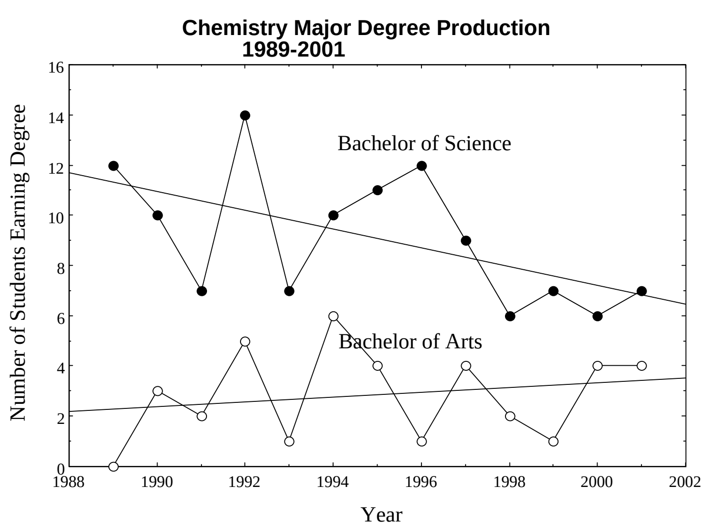
Table 4: Analytical Subfield performance and three analytical chemistry courses

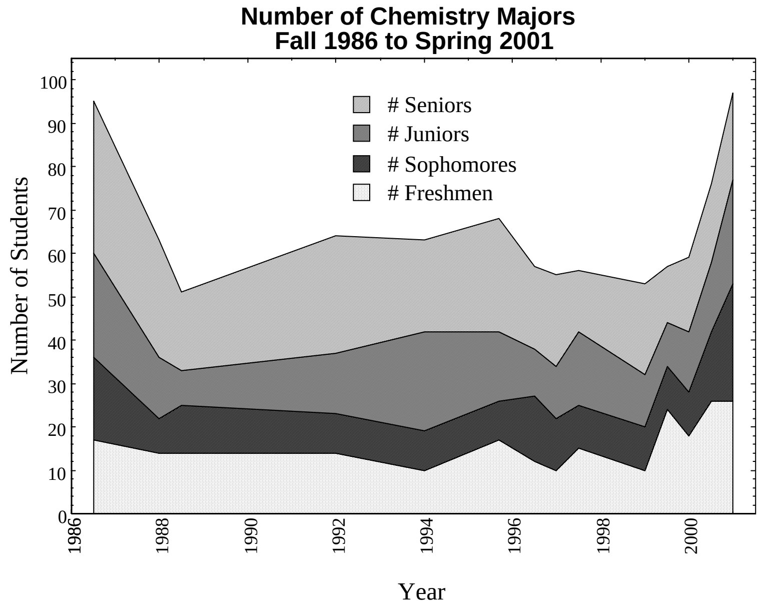
Percentile in the **Achem** subfield	grade in 116	grade in 221	grade in 421
99	4.0	--	--
98	--	4.0	--
94	4.5	--	4.0
94	4.0	--	--
93	--	3.5	--
91	4.0	--	--
86	4.0	--	4.0
81	4.0	--	--
81	3.5	--	4.0
81	2.0	--	3.7
74	4.5	--	4.5
74	3.5	--	2.0
74	3.0	--	--
74	--	??	4.0
56	3.0	--	3.5
56	2.5	--	4.0
56	--	2.0	--
47	--	3.5	4.0
27	--	2.5	3.0

Faculty comments were to wonder whether performance in CHEM 116 and CHEM 221 were high because of innate ability or whether it correlated with the extent of their high school preparation?

B. Undergraduate Degree Production (1986 – 2001)

Our APR document included information about the number of chemistry majors since 1986 and about undergraduate degree production since 1986 (Figures on next page; data was not available for every year or semester). The number of degrees fluctuates considerably from year to year but there does seem to be a trend toward fewer B.S. degrees awarded every year. This observation seems to counter the observation that the number of chemistry majors has increased recently.





1. <u>Is the number of undergraduate chemistry degrees decreasing</u>?

   Two of the figures prepared for the Academic Program Review were shown to the faculty at the September Meeting. The trend observed in the "Chemistry Degree Production 1989-2001" graph seemed to indicate that the number of BS graduates was decreasing quite fast while the number of BA graduates was increasing.

   One comment about these supposed trends were that we seem to be following a national trend. The National Science Foundation has documented a trend of continually decreasing numbers of undergraduate chemistry degrees since 1966. A closer examination of that data (discussed by email after the faculty meeting) revealed that the actual trend was for a decreasing percentage of chemistry degrees relative to non-physical science degrees since 1966. The actual numbers of graduating chemistry majors reached a peak in 1969, decreased to a low in 1992, and have been rising slowly ever since.

   Another faculty member wondered about the impact that the UNL Biochemistry undergraduate program has had on our number of majors. An examination revealed that it appears to have had little impact. The Biochemistry program was activated in about 1992 and had about 200 majors by 1995. The number of students graduating from the Biochemistry program is unknown. Nevertheless, the number of chemistry degrees awarded has not dropped precipitously rather it appears to be a long-range trend.

   Finally, it was pointed out that next year's graduating seniors appear to be greater in number than the projected 6 BS majors and 4 BA majors. The result will be to soften the trend considerably from that projected on the graph.

2. <u>What was the cause of the decline in total number of majors before 1989 and has the recent near doubling of majors been noticed</u>?

   The other figure prepared for the Academic Program Review was "Number of Chemistry Majors 1986-2001". It showed the number of majors separated according to class level. From 1986 until 1989, the number of students in the upper divisions decreased considerably. The numbers of students in each class level held roughly constant between 1989 and 1999. The numbers of freshman, sophomores, and juniors have been increasing since 1999.
   The comments about these numbers were to wonder about a comparison of student quality then and now, to note that our recent increase may be due to an increase in BA majors rather than BS majors, that Chemical Engineering students have been transferring into our program lately, that students in their fifth and higher years would be counted multiple years in a row to cause the "Seniors" category to appear larger than the number of graduating seniors, and to note that students who transfer into our program often do so as upper classmen but have to take lower division chemistry courses which extends their time in our program. There were questions about the degree of student retention over time and whether there are now more transfer students.

C. Chemistry Major performance in required non-chemistry courses

Another question that arose during the faculty discussion last year was whether the majors' requirements in Math and Physics were having the intended effect. Do they prepare our students for our upper division courses? To address this question, I have created a table of GPAs in selected courses for this year's graduating seniors (Table 5). The average grades for this year's graduating students were compared in their required math courses, physics courses, chemistry courses, and physical chemistry courses. The correlated data was ranked according to Overall GPA. In general, Chemistry GPA was slightly higher than overall GPA. In general, Math and Physics GPA was half a grade point lower than overall GPA.

This year's class has a lower overall GPA than the previous three years'. This is reflected in the low GPAs that some of them earned in their Math and Phys courses. The Math courses are 106, 107, and 208 and the Physics courses are 211 and 212. Nearly every student earned Math and Physics GPAs below their overall UNL average GPA. In contrast, their Chemistry GPAs were very similar to their overall GPA. Chemistry appears to be their strength and that is perhaps why they chose it as their major.

Physical Chemistry Chem 481 is required for BS majors and has the Math and Phys prerequisites. In general, it appears that students who fare poorly in Math and Physics are likely to fare poorly in Physical Chemistry. Two of the three students with the lowest GPAs had to retake CHEM 481 at least once to pass it.

Table 5: GPAs in selected required Chemistry Major courses

Student	Overall GPA	Math GPA	Phys GPA	Chem GPA	PhysChem GPA
BA1	*4.2*	*4.0*	*4.0*	*4.2*	*4.0 (took 471)*
BS1	4.0	4.0	4.0	4.2	4.0
BS2	3.6	2.5	2.8	3.9	4.0
BS3	3.2	2.8	3.5	3.0	3.0 (took 481 twice)
BS4	2.9	2.5	1.8	2.9	3.0
BS5	2.6	2.2	2.5	2.3	2.2 (took 481 thrice)

Faculty comments about this data were that the Math and Physics courses are taken early in their undergraduate careers and reflect the heavy competition in these large-enrollment introductory courses. Their Chemistry and Physical Chemistry GPAs are similar to overall GPA because they self-select this major based on their chemical ability.

Conclusions

Considered as a whole, the faculty were pleased with student performance. There is a very good correlation between grades in the relevant UNL Chemistry courses and student performance on nationally standardized exams. An average 80% performance is very good. These results suggest that UNL Chemistry is preparing its students to be competitive on the national scene.