

CHEMISTRY DEPARTMENT 2013 ANNUAL ASSESSMENT UPDATE

I. Mission Statement and Student Learning Outcomes

Department Mission Statement, Goals, and Outcomes can be found at http://www.westmont.edu/_academics/departments/chemistry/goals.html

II. Follow up on Action Items Identified in Previous Reports.

The action items from the 2012 response to our annual report are listed below as well as the steps we have taken to address them.

1) On the revising of our learning outcomes.

We have separated benchmarks from outcome statements as requested. See website above to review changes.

2) On the attitudinal aspects of outcomes 3 and 4.

We have revised goal 3 to eliminate the word “appreciate”. The goal now reads: “Students will be skilled in working in the laboratory and will be competent in experiment design and problem solving by the time of graduation.” We have also eliminated the indirect assessment of goal 4 and replaced it with a direct assessment. The direct assessment is a poll of our graduates asking them directly about their enthusiasm and love for learning chemistry.

III. 2012/2013 Focus

Our 2012/2013 focus are goals 3 and 4 which now read:

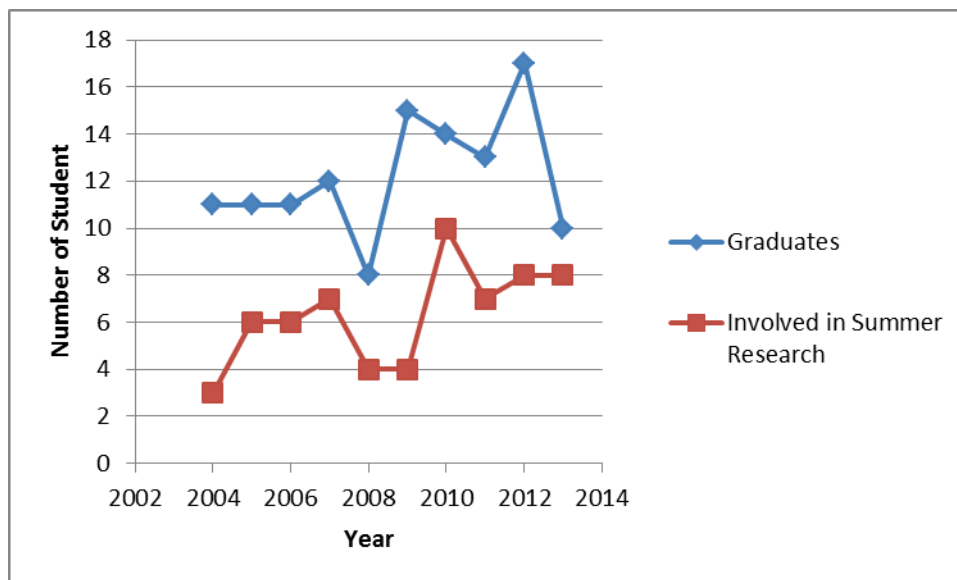
3. **Students will be skilled in working in the laboratory and will be competent in experiment design and problem solving by the time of graduation.**
4. **Our students will develop a love of learning and an enthusiasm for chemistry as a science and a discipline.**

We propose to assess goal 3 in three ways: i) By tracking the involvement of our students in summer research either at Westmont or another facility; ii) by tracking how many of our students complete a major honors project; and iii) by administering an essay exam on experimental design in the senior level physical chemistry laboratory. We propose to assess goal 4 by administering a survey to our graduates.

A. Involvement of undergraduate students in summer research.

1) Number of Students

The table below shows the number of students involved in summer research in the chemistry department at Westmont as well as the number of graduates from our department for the period 2004-2013.



The number of students involved in summer research has grown slightly over the years. The average number of graduates over the period is 12.2 and the average number of students involved in research is 6.3, so the average participation rate is 52%, which exceeds our benchmark (50%).

2) **Student Satisfaction with Undergraduate Research.** The data below summarizes the overall results of questionnaires administered to students involved in summer research for the period 2010-2013.

How would you rate your overall summer research experience?

Response	# of Students
a) Outstanding	18
b) Excellent	8
c) Satisfactory	1
d) poor	

How helpful do you think your summer research experience will be in helping you get into graduate school or find a job after graduation?

Response	# of Students
a) Very Helpful	26
b) Moderately Helpful	1
c) Not Helpful at All	

Would you recommend a similar summer research experience to your peers?

Response	# of Students
a) Yes	27
b) No	0

Please list the strengths of your summer research experience.

Common answers included:

- Improvement of lab skills
- Working closely with professors
- Learning how to use instruments
- Learning and improving lab techniques
- Hands on experience in chemistry
- Resume building

Please list the weaknesses (if any) of your summer research experience.

Most responses indicated no weaknesses. A minority of students mentioned these:

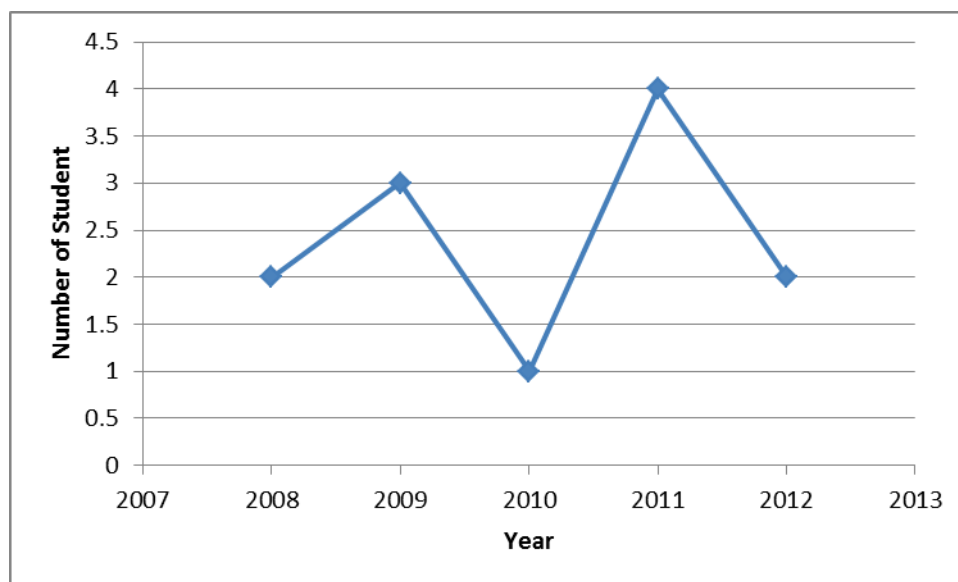
- Long hours
- Problems with equipment
- Would like the program to be longer

Department discussion of student involvement in summer research

The department is satisfied with the number of students involved in undergraduate research. In our department, over 50% of graduates participate in summer research. We doubt that many other chemistry departments in the country can boast that level of participation. We are currently limited, not by student interest, but by funding. We anticipate that the Stauffer challenge grant will provide us with additional funding which allow us to achieve an even higher participation rate. In addition, students seem very satisfied with their experience.

B) Students completing major honors projects.

The number of students completing major honors projects is summarized below.



The average number of students completing honors projects over the period is 2.4 per year.

Department discussion of students completing major honors projects.

The department is satisfied with the number of students completing major honors projects. The average of 2.4 students per year exceeds our benchmark (2 students per year). There is some concern that since this benchmark is an absolute number, rather than a percentage of graduates, fluctuations in number of graduates may affect the outcome. However, we can mitigate against that by computing a rolling average over 5 years, as we did in this report.

C) Essay exam on experimental design

Our department administered an essay exam on experimental design in our advanced analytical chemistry course, which is populated by our juniors and seniors. The exam was based on a rubric published in the Journal of Chemical Education¹. The entire rubric is posted in our departmental assessment folder. Briefly, the exam has three questions and each question is assessed on three criterion:

- 1) The student identifies the important or relevant features of the problem.
- 2) In formulating a strategy for the solution of the problem, the student presents a complete justification or explanation of the strategy.
- 3) The student provides an effective strategy that is likely to work to solve the chemical problem.

Each criterion is given a numerical score from 1-4 with 1 indicating that the student's response indicates an emerging understanding and a 4 indicating that the student's response indicates mastery. The maximum score on the essay exam is therefore 36, which would indicate mastery of all three criterion for all three question. The exams were graded by two department members (Everest and Contakes) and average results are tabulated below.

2011 Results

Student	Question 1			Question 2			Question 3			Total	Jr/Sr?
	C1	C2	C3	C1	C2	C3	C1	C2	C3		
GJ	3	2.5	3.5	3.5	3	3	4	3	3	28.5	S
A	3	2	2.5	3	2	2.5	3	2.5	4	24.5	?
B	Did not answer			1.5	1	2	Did not answer			4.5	?
JM	3	2.5	3	3	2.5	3	3	2.5	4	26.5	S
DL	3	2.5	3	3.5	3	2.5	2.5	3	1.5	24.5	J
CO	3.5	3.5	3	2.5	2	3	3	3	2.5	26	S
AB	3	3	3	3	2.5	3	3	2.5	4	27	S
C	3.5	3	3.5	3	2.5	2.5	3	3.5	2.5	27	?
D	3.5	3	3.5	2.5	2	3	3.5	2.5	4	27.5	?
E	1.5	1	1.5	1	1	1.5	Did not answer			7.5	?
DC	2	2.5	2.5	2.5	2	2	2	2	2	19.5	?
SG	3.5	3	3	3	3.5	3	4	3.5	4	30.5	J
Averages:	2.95	2.59	2.91	2.67	2.25	2.58	3.10	2.80	3.15	22.79	
Stdev	0.65	0.66	0.58	0.75	0.75	0.51	0.61	0.48	0.97	8.31	
90% confid	0.32	0.33	0.29	0.37	0.37	0.25	0.30	0.24	0.48	4.11	

¹ S.E. Shadle, E.C. Brown, M.H. Towns, and D.L. Warner, *A Rubric for Assessing Students' Experimental Problem-Solving Ability*, J. Chem. Educ. 2012, 89, 319-325

2012 Results

Student	Question 1			Question 2			Question 3			Total	Jr/Sr?
	C1	C2	C3	C1	C2	C3	C1	C2	C3		
HR	3	2.5	2	2.5	2.5	1.5	3	2.5	3	22.5	S
AC	2	2.5	2.5	3	2	3	2	2.5	1	20.5	S
TS	3.5	3.5	3.5	3.5	3	2.5	3	2.5	3.5	28.5	S
SL	3	3	2.5	2.5	2.5	1.5	2.5	2.5	2	22	S
EP	3	2.5	3.5	3	2	3	3	3	4	27	S
BD	2.5	3	2.5	3	2.5	3	3.5	3	4	27	J
HT	2.5	2	2.5	3.5	2.5	2.5	2.5	2.5	1.5	22	J
CB	2.5	2.5	2	2.5	2	2.5	2.5	2.5	1.5	20.5	S
A2012	2.5	2	2	3	3	3	3	2.5	4	25	?
SZ	3	3	3.5	3	2.5	3	3.5	3	3.5	28	S
Averages:	2.75	2.65	2.65	2.95	2.45	2.55	2.85	2.65	2.8	24.3	
Stdev	0.42	0.47	0.63	0.37	0.37	0.60	0.47	0.24	1.18	3.15	
90% confic	0.25	0.27	0.36	0.21	0.21	0.35	0.27	0.14	0.69	1.82	

For comparison, the authors of the paper in which this rubric was published reported that their students achieved an average score of 20 as juniors and 28 as seniors.

Department discussion of essay exam on experimental design

The department is generally satisfied with the results of the essay exam on experimental design. Students met the benchmark (24) in 2012. However, the department thinks we can improve even further by modifying the CHM 122 curriculum to include the following:

- 1) Add an NMR analysis component to the deconvolution of IR spectra lab to illustrate use of NMR to quantify relative amounts in a mixture.
- 2) Add an NMR analysis component to the diethyl malonate methanolysis kinetics lab to demonstrate how NMR can be used to follow the kinetics of the reaction.
- 3) Add more discussion of gas and liquid chromatography to the course to demonstrate a broader applicability of these techniques to chemical problems.

D) Survey of Graduates




Our department administered a survey to our graduates asking them about their view of chemistry and their enthusiasm for the discipline. The survey was sent to 100 alumni and 68 responded. The results of the survey follow.

1. My experience in the chemistry department at Westmont College developed in me an enthusiasm and love for learning chemistry.

		Response Percent	Response Count
a) Strongly agree		63.2%	43
b) Moderately agree		16.2%	11
c) Agree		16.2%	11
d) Disagree		4.4%	3
e) Strongly disagree		0.0%	0
	comment		25
	answered question		68
	skipped question		0

2. Regardless of your current occupation, how do you view the discipline of chemistry today?

		Response Percent	Response Count
a) Very positively		61.8%	42
b) Positively		32.4%	22
c) Neutral		5.9%	4
d) Negatively		0.0%	0
e) Very negatively		0.0%	0
	Optional Comment		12
	answered question		68
	skipped question		0

3. Please indicate the range of your graduation date.			
		Response Percent	Response Count
a) 2000 - 2003		13.2%	9
b) 2004 - 2007		36.8%	25
c) after 2008		50.0%	34
answered question			68
skipped question			0

The survey shows that 95.6 % of our graduates agree, moderately agree, or strongly agree that their experience at Westmont developed in them an enthusiasm and love for learning chemistry. Some selected comments follow: (For a full list of comments see Appendix I)

“I hated Chemistry in HS for various reasons, but Westmont completely turned that attitude around. By the time I graduated Westmont I wish I had been able to take more classes.”

“All of my professors in the chemistry department had a clear passion for chemistry, and this had a direct impact on my enthusiasm for chemistry and my dedication to the learning process.”

“I have carried on my love of learning chemistry into my graduate studies. Sometimes that love is tested...”

“For me, it was really the enthusiasm and joy of the professors that made me develop my own passion for chemistry. I may not be pursuing chemistry as my future, but it taught me a lot of skills I continue to use now in optometry/graduate school.”

The results also show that 97.2 % of our graduates view the discipline of chemistry either positively or very positively. Some selected comments follow: (For a full list of comments see Appendix I)

“While my current occupation isn't in the field of chemistry, I view the discipline of chemistry, and the time I spent studying it, rich and valuable. My understanding of chemistry provides me with a deeper appreciation of the world that I couldn't have gotten otherwise.”

“I'm currently working in a lab that focuses on biology. While I have little to no interaction with chemistry on a day to day basis for my job, I do find that my knowledge of chemical interactions is beneficial and puts me above some of my peers who come from a strictly biological education background”.

“I have begun to appreciate chemistry more as I have learned that chemistry does not live in a vacuum. The field of chemistry enriches and is enriched by many other fields of research in

both academia and industry. Observing and understanding how chemistry impacts researchers in many fields today gives me a very positive view of the discipline of chemistry.”

Department discussion of survey of graduates

The department is very pleased with the results of our survey of graduates. Our benchmark was that 75% of our graduates would self report that Westmont chemistry experience developed in them a lifelong enthusiasm and love for chemistry, and we have exceed that benchmark by more than 20 percentage points.

IV. Next Steps

- 1) Next year our six year assessment report is due. The department chair will write the report with the help of the administrative assistant.
- 2) Continuing yearly tasks:
 - a. Each faculty member will continue to administer the ACS Exams in each of our courses where it is available, and we will also continue to track student's scores on the MCAT. These data are collected by the department chair and posted to the chemistry assessment archive website.
 - b. Faculty member teaching Seminar (CHM 195) will continue to administer our yearly instrument to assess outcome 5. The current year's results based on the prompt, *Describe the relationship between scientific knowledge and the Christian Faith*, are in our assessment folder.
 - c. Faculty member teaching physical chemistry lab (CHM 132 and 133) will continue to administer our yearly instrument to assess outcome 3.
 - d. The department as a whole will continue to track the career choices of our graduates. This file is in our department archive and will be updated every year or two as necessary.

Appendices:

I – Survey Comments

Appendix I – Survey Comments

Q1. My experience in the chemistry department at Westmont College developed in me an enthusiasm and love for learning chemistry.		
1	When I got to upper level courses I realized I was more interested in natural sciences, but I still retain my love of chemistry.	Feb 12, 2013 8:59 AM
2	I hated Chemistry in HS for various reasons, but Westmont completely turned that attitude around. By the time I graduated Westmont I wish I had been able to take more classes.	Feb 6, 2013 8:25 AM
3	Honors General Chemistry with Niva Tro was the beginning of my passion and "career" in chemistry.	Feb 5, 2013 9:59 AM
4	All of my professors in the chemistry department had a clear passion for chemistry, and this had a direct impact on my enthusiasm for chemistry and my dedication to the learning process.	Jan 29, 2013 2:42 PM
5	Best decision I ever made was to be a chemistry major. Not only did it give me a love of science, but a love of learning.	Jan 28, 2013 5:26 PM
6	I enjoyed everyone I worked with in the Chemistry Department. The introduction to research, I believe, truly changed my life. The seminar with Dr. Contakes was one of my favorite classes at Westmont - I felt I received some valuable tools to integrate faith and science. The research with Mako was so rewarding - even though he wasn't able to stay for the whole time. I can't say enough good things about the Chemistry Dept at Westmont.	Jan 28, 2013 6:42 AM
7	A love and enthusiasm for learning but not necessarily chemistry.	Jan 26, 2013 3:38 PM
8	While at westmont I felt overshadowed by other students in all my chemistry classes and I didn't feel that I was helped enough with planning out my career path for after graduation. I think something needs to be done for students who know they love chemistry but can't figure out the direction they want to go in yet. That being said I thought all my professors here conveyed the subject material excellently and I finished with a decent background in chemistry. My overall experience at westmont ultimately was very negative socially, but one of the few reasons I am glad I stayed the four years is my involvement with the chemistry department through research and classes. It is very intellectually challenging and should stay that way.	Jan 25, 2013 9:26 PM
9	My class with Tro did this. He was an awesome prof to have for an intro chemistry class and his own book was very helpful. I really liked the professors after that like Contakes, but the subject material just was never as interesting as the life around me at westmont. I always felt that maybe I should have been a bio major or something else. (As is I am pursuing a masters degree in Marine Biology currently in Monterey Bay)	Jan 25, 2013 6:01 AM
10	I am glad for what I learned while in school, however I have no desire to learn anything that in depth in the future. My interest lie in the overarching principles.	Jan 24, 2013 8:36 PM
11	I have carried on my love of learning chemistry into my graduate studies. Sometimes that love is tested...	Jan 24, 2013 7:04 PM
12	I especially found a love for physical chemistry	Jan 24, 2013 5:27 PM

Q1. My experience in the chemistry department at Westmont College developed in me an enthusiasm and love for learning chemistry.

13	Originally I was a bio major and upon getting involved in the chemistry department I discovered my love for chemistry. I now plan to teach chemistry in the future after I get my PhD.	Jan 24, 2013 5:07 PM
14	I initially disliked chemistry, but learned in honors general chemistry that chemistry was in fact the building blocks of why I understood science so well. The lessons I learned at westmont still inspire me in my learning now as a medical students, and drive me to inspire other young students in the high school science afterschool program I run.	Jan 24, 2013 4:31 PM
15	I was on a pre-med track and so I never envisioned myself doing much with chemistry after undergrad.	Jan 24, 2013 4:30 PM
16	This is a really tough one, because I think I would have studied something else, if I could do it all over again. But, that's not fair to you guys, because I don't think I was ready to choose a discipline at that point in my life. I think I really chose chemistry because the professors (tro, mako, contakes) loved it so much. I didn't really see that in any other professors. I really wanted to enjoy something as much as you guys did. I liked gen chem because of Tro, and i convinced myself everyone hates ochem, so i pressed on. by the end of ochem, I realized that chemistry isn't my thing. I had to either finish, or spend another year there, and another \$40,000+, so I finished, and found something I liked better in graduate school. If I could, I'd choose the bubble that said "Westmont instilled in me an enthusiasm and love for chemistry my first year, but then by my third year I realized that awesome professors can't make me enjoy something that I just don't like." Sorry for the long response.	Jan 24, 2013 3:45 PM
17	For me, it was really the enthusiasm and joy of the professors that made me develop my own passion for chemistry. I may not be pursuing chemistry as my future, but it taught me a lot of skills I continue to use now in optometry/graduate school.	Jan 24, 2013 3:35 PM
18	I am a physician now. Chemistry was something I could do and a means to a career end. I was better at math than rogue memorization, thus I choose chemistry over biology as a major.	Jan 24, 2013 3:24 PM
19	While I considered going to grad school before I ever got to Westmont, it was my experience with all of the professors that ensured it. The enthusiasm that was exhibited in the classroom, the thirst for knowledge and understanding in discussion, and all of the attention given to the students was key in this.	Jan 24, 2013 3:18 PM
20	Though chemistry is not the field into which I am entering, my time at Westmont instilled in me a love and passion for the chemistry behind every aspect of medicine. It is remarkable, and I credit the Chemistry Department at Westmont for this enthusiasm.	Jan 24, 2013 3:17 PM
21	The professors and staff were great and very enthusiastic.	Jan 24, 2013 3:17 PM
22	I came to Westmont as a biology major, but my experience in lower division chemistry classes inspired me to switch to a chemistry major.	Jan 24, 2013 3:07 PM
23	Though my interests have moved away from the sciences since graduating, the	Jan 24, 2013 3:06 PM

Q1. My experience in the chemistry department at Westmont College developed in me an enthusiasm and love for learning chemistry.

educational experience at Westmont in the Chemistry Department was wonderful. I am grateful to have been able to participate in research, learn from accomplished and challenging professors, and integrate science (and chemistry) with my Christian faith.

24	The enthusiasm of the faculty is apparent and contagious!	Jan 24, 2013 3:04 PM
25	I definitely love learning chemistry and I feel that all of my chem profs at Westmont truly love chemistry as well as learning and teaching chemistry too!	Jan 24, 2013 2:59 PM

Please continue to next page for question 2.

Q2. Regardless of your current occupation, how do you view the discipline of chemistry today?

1	I'm a farmer that processes our own fruit. Chemistry is all throughout my job.	Feb 12, 2013 8:59 AM
2	While I may not be doing Chemistry in my day to day life, the classes, labs, and research helped me develop creative problem solving skills that I do use day to day.	Feb 6, 2013 8:25 AM
3	While my current occupation isn't in the field of chemistry, I view the discipline of chemistry, and the time I spent studying it, rich and valuable. My understanding of chemistry provides me with a deeper appreciation of the world that I couldn't have gotten otherwise.	Jan 29, 2013 2:42 PM
4	It's given me a strong background for my profession.	Jan 28, 2013 5:26 PM
5	Chemistry is so broad and interesting and I love that aspect.	Jan 26, 2013 3:38 PM
6	Grad school has helped me figure out what subject areas in chemistry I'm interested in and I have enjoyed every class I have taken so far, and the research I've been involved in here.	Jan 25, 2013 9:26 PM
7	I'm currently working in a lab that focuses on biology. While I have little to no interaction with chemistry on a day to day basis for my job, I do find that my knowledge of chemical interactions is beneficial and puts me above some of my peers who come from a strictly biological education background.	Jan 25, 2013 6:18 AM
8	I think Chemistry is very important and respect the people who can be passionate about chemical research. At some level everything around us is chemistry and to understand ourselves and our world better, we need the careful insight of skilled chemists	Jan 25, 2013 6:01 AM
9	Even though my job is classified as biochemistry, I frequently use my knowledge of chemistry to understand and interpret experimental results. Chemistry as a discipline is paramount to any scientific career.	Jan 24, 2013 8:36 PM
10	I have begun to appreciate chemistry more as I have learned that chemistry does not live in a vacuum. The field of chemistry enriches and is enriched by many other fields of research in both academia and industry. Observing and understanding how chemistry impacts researchers in many fields today gives me a very positive view of the discipline of chemistry.	Jan 24, 2013 7:04 PM
11	They only thing that could make me love chemistry more is if I could make ice cream with liquid nitrogen more often :P	Jan 24, 2013 4:31 PM
12	I admire people that can do it and enjoy it. Before I decided to do something else, I was scared I'd be working for a pharmaceutical company that did nothing but rewrap old drugs to get a new patent to keep making money. At the time, it seemed absolutely necessary to go to graduate school to do anything but be a lab rat	Jan 24, 2013 3:45 PM