Student Learning Report (Assessment 2015) TMCC Science and Math Department

Goals

The plans/goals of the Science/Math Department in terms of assessment include looking for a 70% average mastery of competencies in Science and Math. This can either be determined from averaging all tests, or averaging post-tests, which have representative questions of all competencies, and involve fewer data. We also extended the 70% goal to evaluation of other general education outcomes, if assessed within the individual courses.

A 70% mastery level is basically the bottom of "C" level achievement in most academic courses, or "average." At the heart of assessment is determining whether we are satisfied with half of the students in a course being within or above the "average" classification, and half below "average," which is statistically the definition of 70% average mastery.

Idealistically, we believe that there are no limits to student achievement when faculty and administrators are very pro-education, as is evidenced at TMCC in terms of the quality of the courses, and as long as students are willing to work very hard. Realistically, there are a few roadblocks, some of which are documented. Placement tests and pre-tests show low mastery in a number of areas, particularly communication and math. The students are usually here only for two years, and many students have interrupted educations or take care of family and outside jobs. This all conspires to compete with student study time.

Results (Please see table 2 below for more detail)

Science: 2/3 of instructors (all of whom teach science) found students below the 70% average mastery.

Recommendations included:

- Attendance/grades made available to students on a weekly basis in class
- Lab activities and PowerPoints on study skills
- Peer tutoring

Math: 2/5 of instructors who teach or use math found students below the 70% average mastery (one of these instructors is a math instructor).

Recommendations:

- Math tutoring by the college strongly advised
- Less lecture and more practice on problems in class
- Absenteeism addressed (although method was not discussed)

Communication: 1/3 instructors who evaluated communication skills found that students were deficient in written expression (below 70% average mastery)

Recommendations:

- Offering more opportunities to write in class
- Reviewing of common mistakes and how to correct them with the entire class

Critical thinking: 3/6 instructors who evaluated for critical thinking found students deficient in critical thinking (students short of the 70% average mastery).

Recommendations:

- Increase the number of text-based critical thinking problems
- Increase the number of multi-step math problems involving critical thinking

Technology: 5/5 instructors found students proficient (above 70% average mastery) in the use of technology. Note: Technology was defined differently based on the course: Scientific technology mastery involved laboratory equipment and instruments, as well as data manipulation via computer software in some cases, while mathematical technology involved use of calculators and computers in computational situations.

Instructors still felt that improvement could be achieved:

Recommendations:

- Monitor students on one-to-one basis to make sure each student successfully uses technology correctly
- Spend more time on technology concepts, not just manipulation
-

Culture: 2/2 instructors found that students scored above a 70% average mastery of their own definition. There was a large gap between the number of instructors evaluating cultural orientation and the number expected to do this, since it is a mission statement of the college to include some cultural material within each course. Recommendations were confined to those who actually evaluated for this:

Recommendations:

- A number of instructors would like to see a bank of ideas for inclusion or perhaps some tutorial workshops.
- Since students engage in a cultural pre-test administered by the college, it might be beneficial to bring the actual test to the attention of instructors, so that they can emphasize the same material

Assessment instruments (Please see table 2 below for more detail)

Individual assessment tools varied for each instructor. For most instructors, the general education outcome which is their area of expertise was evaluated by pre- and post-test instruments, which were essentially shortened forms of what is contained in the semester tests. For non-expertise areas, instructors in the science and math department used writing assignments, essays and individual test questions, usually listed as evidence within each of their assessment reports. Some used entire tests, feeling that the test not only illustrated science or math principles, but also showed critical thinking and technology skills at the same time.

Interpretation of Findings

Technology was the only general education outcome which was interpreted as being above 70% mastery in all courses which were evaluated by a consensus of instructors. Cultural diversity was also unanimously evaluated as exceeding 70% mastery, but only two instructors actually had an assessment tool for culture, which is not nearly enough. For the rest of the general education outcomes, 1/3 to 2/3 of the instructors agreed that students as a group did not achieve a 70% average. Instructors often recommended that more critical thinking, more math, more science, more technology

and communication be put into their repertoire, but the fact remains that there is only so much instructional time, and students can only take in so much information during a semester. Emphasizing one skill may be at the expense of another. A number of remedial strategies may involve requiring additional courses, either developmental or as part of the major.

Other reflections:

1. Notification of having to supply gen ed assessment was very late in the semester. Department meetings resulted in faculty knowing what to do for next year, but many could not produce all gen ed statistics for this year.
2. Department meetings resulted in giving faculty some ideas on what to do for critical thinking, technology, cultural and communication assessment activities and assessment tools.
3. Some gen ed assessments have 30% of the students in the "poor" category. Is this OK? However, nearly every instructor on the FARM showed huge gains between pre- and post-test, so work is being accomplished. Maybe this should be a major category in a report to HLC.

4. Let's address some student issues: Lack of attendance, lack of homework completion, apparent lack of study time. Some students may lack a serious approach to school, but are there other things causing problems: jobs, children, transportation? Is there a problem with putting high-risk students into only 12 hours full-time? There seems to be a big rush to get them through, even if they are not viable when they are done.

Every semester several instructors produce tables like the one below, showing correlation of lower grades with High absence and low homework output:

Table 1: Spring 2015 Chem 116:

Grade	avg. absences	avg. homework grade	avg. lab grade
A	3	92	100
B	4	86	100
C	9	54	91
D			
F			

Institutional Recommendations:

1. Change Chem 116 Introduction to Organic Chemistry and Biochemistry into a 2-semester course. Advantages: Both subjects explored thoroughly- important for nursing students especially. Rationale: Please see attached report page 7.

2. Math personnel feel that Math 100 could be dropped, since math basics could be included with Intermediate Algebra 102 and Technical Math 130, resulting in a great deal of time being saved since it does not take an entire semester to work through math basics.

3. Since science instructors have noticed poor scores in metric conversion, significant figures operations, scientific notation, and factor labeling, it is suggested that all Associate of Science majors who cannot pass a technical math placement test be required to take Technical Math 130 prior to chemistry and physics classes. Please see attached report for rationale page 8.

Science instructors have also noted very poor algebra skills in Chem 115 despite the prerequisite of Intermediate Algebra 102 or placement into Algebra 111. It is suggested that the math placement test be updated (with a "math for science" component), that high school courses not be given preference over placement scores, and that Technical Math 130 be required for students who do not pass the "math for science" placement test; this implies That Technical Math 130 will also contain an algebra review with emphasis on science-based text problems. Please see attached report for rationale page 8 and 9.

4. Require a grade of "C" or above to continue to the next course in science sequential courses . Please see rationale for this in attached report page 10 and 11.

5. Have school counselors visit developmental classes and supply students with information on technical or vocational study programs as well as academic, and present an overview of degrees and related job opportunities, and what is involved in different jobs. This could also be done during an orientation session or study skills course. Anecdotally, instructors have noted that a number of students seem to know little about the college programs available and what type of work is related to them. Perhaps courses like "vocational survey" (akin to "science survey") might allow students to do short projects in a number of CTE areas, such that they could evaluate these disciplines in terms of what they personally prefer.

6. Research opportunities for undergraduates must be increased, since it has been shown in national literature, as well as at TMCC (Padmanabhan, LaVallie paper presented at American Society of Engineering Educators in 2013) that research opportunities are correlated with increased student success in STEM areas as well as increased retention of these students in STEM and movement into 4-year programs and beyond. However, an average of only three instructors (the same ones) per semester write grants and conduct research here on campus.

   Research does not have to be in science and math, and, since it is a stated goal in the mission statement of TMCC, all departments should be researching, writing and conducting grant work.

Table 2: Department Statistics

Assessment of Student Learning Report TMCC Science and Math Department
Spring 2015

Science Assessment spring 2015 target: 70% average mastery	**Faculty**	**area of expertise and # competencies**	**Class and #students**	**assessment instrument**	**Results percent average**	**Results good fair poor %**	**Achieved 70% mastery?**
	A LaVallie	yes- 10	Intro org chem- 19	pre/post	75%	37, 31, 32	yes
	D Hunter	yes- 10	Microbiology- 15	pre/post			
	S Blue	yes- 4	sci survey- 7	exams	66%	38, 27, 35	no
	C Hill	yes- 3	Geog 121- 11	pre/post usually post not given exams used		39, 0, 61 Lab 79%	no yes
Math Assessment spring 2015 target 70% average mastery	M Pfahl	Yes- 5	Math 112- 12	pre/post	84%	77% by tests	yes
	L Olson	Yes- 5	Math 111	pre /post	60%	60% by tests	no
	D Henry	Yes- 7	Applied Math - 11	pre/post	87%	89% by tests	yes
	A LaVallie	No	intro org chem- 19	lab section		80, 20, 0	yes
	C Hill	No	geog 121- 11	Midterm Qs		22, 0, 78	no
Critical Thinking Assess. Spring 2015 target 70% average mastery	A LaVallie	Gen Ed	as above	lab problems		32, 47, 21	yes
	D Hunter						
	S Blue			tests- all		38, 27, 35	no
	M Pfahl			problems		56, 22, 22	yes
	L Olson			problems		24, 27, 48	no
	D Henry			tests, chap 6,9	86%		yes
	C Hill			Final test Qs		22, 0, 78	no

Technology Assess. Spring 2015 target 70% average mastery	A LaVallie	Gen Ed	as above	overall lab grade	94%		yes
	D Hunter						yes
	M Pfahl			test chap 7	75%		
	L Olson			problems		49, 32, 20	yes
	D Henry			tests chap 6,9	86%		yes
	C Hill			overall lab grade	79%		yes
Communication Assess. Spring 2015 target 70% average mastery	A LaVallie	Gen Ed	as above	research; essay		31, 53, 16	yes
	D Hunter						
	C Hill			tests- short ans		18, 0, 82	no
	M Pfahl			journaling		83, 8, 8	yes
Cultural Assess. Spring 2015 target 70% average mastery	A LaVallie	Gen Ed	as above	PP present; quiz	85%		yes
	D Hunter						
	C Hill			midterm Qs		50, 20, 30	yes

Evidence for Recommendation

Recommendation: Changing Chem 116 " Introduction to Organic Chemistry and Biochemistry" from a one-semester course to a two-semester course:

From 2007 onward, both Deborah Hunter and I have noticed that it is extremely difficult to cover all the material proscribed for the course within one semester, often squeezing biochemical chapters into a scant few weeks at the end of the semester. Because most of the students have had no prior organic chemistry experience, it takes the majority of the semester to cover just the fundamentals of organic chemistry.

In spring 2015, I did not cover the last three chapters of the textbook (some of the biochemical material) because I had taken more time and trouble on the organic portions of the course, as well as having the students take one more test than usual.

When all tests over the organic material of the class were averaged for the entire class, the following means were noted for 2015 (extra time on organic material) and 2014 (no extra time):

2014: 74 mean

2015: 81 mean

Another result was that in the spring 2015 class, the following low grades were noted:

2015: no D or F grade

This is different from prior semesters, where lower grades appeared:

2014: 2 D

2012: 1 F

2009: 1 F

2007: 3 D

Another consideration here is that biochemistry should be treated with an entire semester, which would allow instructors to introduce material on the growing science of genetic expression. Right now, the majority of our students in Chem 116 are nursing students, and over half of them are not able to pass the final nursing exam; a longer and more thorough course in biochemistry would only improve their chances.

Evidence for Recommendation

Recommendation: Upgrading math placement tests and assigning more math prerequisites for science courses.

Evidence from A. LaVallie:

The first two weeks in Chem 115 are spent on "review" of basic math skills of metric conversion, factor labeling, significant figures and operations with them, scientific notation, and instrumental scale interpolation (these are called "technical math" skills by math instructors).

In every Chem 115 class it has been found that the majority of students are so deficient in these skills that even with a two-week review, the quiz over the material results in an average low score:

2012: 57% 10 out of 26 students had 70% or above

2015: 53% 6 out of 26 students had 70% or above

Chem 115 courses in other years displayed similar quiz results. Many of the deficient students would benefit from a course in "technical math" prior to enrolling in any chemistry course. The same students are probably weak in algebra, and algebraic skills should also be reviewed in Technical Math 130.

Algebra skills in general are not always up to par with so-called intermediate algebra skills, which are prerequisite to the course.

The tests from Chem 115 in 2014 show typically weak results for math-based problems:

1. "If there are 15 g of C in a sample of $CaCO_3$, how many grams of oxygen are there?"

   40% of the students answered correctly. Solution of this problem depends on understanding percentages and ratios.

2. "If 18 g of C, 3 g of H and 24 g of O react together to form a molecule, what is the empirical formula of this molecule?"

   36% of the students answered correctly. Solution of this problem depends on ratios and division.

3. "Using the reaction: $2\ KClO_3 \rightarrow 2\ KCl + 3\ O_2$
   a) If we start out with 1.5 g of $KClO_3$, how many grams of KCl will we produce?
   b) If we actually get 0.57 g of KCl at the end of the reaction, what is the percent yield?"

   33% of the students could only answer half the question, and only 8% could answer parts a and b. Solution of this problem depends on finding a multiplicative factor and applying it to all species.

4. "In the reaction: $2SO_2 + O_2 \rightarrow 2\ SO_3$
   If 0.5 moles of O_2 are reacted with 1.5 moles SO_2, how many grams of excess reagent are left?"

   One student, or 4% of the total 24 students, could answer this question. The solution to this problem depends on finding a limiting reagent by auditioning multiplicative factors and then applying the correct one to all species in the equation.

5. " You have 0.5 L of a 0.2 M solution of NaOH. You want to end up with 100 ml of a 0.15 M solution. What volume of the 0.2 M solution will you have to dilute?"

   32% of the students could answer this question. The solution to this problem depends on a simple algebraic manipulation with four variables (one unknown).

6. " If 0.010 L of 0.5 M NaOH is neutralized by 0.024 L of H_2SO_4. What is the molarity of the H_2SO_4?"

   36% of the students could answer this question. The solution to this problem also depends on a simple algebraic manipulation with four variables (one unknown) and then a simple division problem.

Discussion: These are poor results, particularly since mastery of a great deal of inorganic chemistry does depend upon mathematical ability. They are also typical results, although tests from prior years are no longer available to peruse. Granted, there is a certain amount of conceptual knowledge in setting up the mathematical equation, but experience in algebra should lend some problem-solving ability in this area.

There is also some ambiguity as to whether students just plain cannot do math well, or are avoiding the math-based problems, content to earn a "C" on an exam by doing only problems that depend more on subjective recall.

It is recommended that the absence of these skills be looked for more closely, by upgrading the math placement tests to include a section designed by science teachers. It is also a common practice to allow priority of student high school courses over placement results, which should be reversed.

When students cannot pass the placement test for technical skills and simple algebraic word-based skills, it is recommended that they attend the Technical Math 130 course prior to electing science courses- particularly chemistry courses.

Evidence for Recommendation

Recommendation: Requiring students to have a "C" or better grade before proceeding to the next science or math course in a series.

Evidence from A. LaVallie is limited:

In going from Chem 115 to Chem 116:

In 2008, four students had a "D" grade in Chem 115 and none moved on to Chem 116 or Chem 121.

In 2010, three students had a "D" grade in Chem 115 and none moved on to Chem 116 or Chem 121.

In 2011, four students had a "D" grade in Chem 115 and none moved on to Chem 116 or Chem 121.

In 2013, two students in Chem 115 had a "D" grade and only one of them attempted Chem 116, and withdrew.

In 2014, five students had a grade of "D" in Chem 115; only two attempted Chem 116, but achieved the grade of "C" for the class.

It could be argued that due to the nature of Chem 115, which is primarily inorganic in theme, and the completely different emphasis in Chem 116, centered on organic chemistry, that students often handle the two very differently in terms of math ability and preference. I am only partially convinced that a "D" in one spells the same limitation in the other.

For Chem 121 and Chem 122, the two-semester suite of freshman inorganic chemistry, the success or nonsuccess in the one could be surmised to definitely influence the success in the next. However, actual evidence is very limited:

In 2008, three students had a "D" grade in Chem 121, and one did elect to move on to Chem 122, in which he/she earned an "F."

In 2009, one student had a "D" grade in 121, and did not elect to take 122.

In 2012, two students had a "D" grade in 121, and did not elect to take 122.

In 2013, one student had a "D" grade in 121 and also did not elect to take 122.

In 2014, one student had a "D" in 121 and also did not take 122 the following semester.

It would appear that because of the difficulty encountered by these students in the first semester, they themselves felt it would not be a successful move for them to continue onto Chem 122.

In physics classes, only a few students who had difficulty made it to the end to receive a "D;" most students are very prepared for the difficulty of the class. None of the few students who received a "D" in physics 211 or 251 elected to go onto the next course of 212 or 252.

However, in the biological studies, a good number of students who do receive a grade of "D" in Biol 150 or in A&P 121 do apparently attempt to move onto the next semester. Dr. Hunter has found that there are problems with the "D" students achieving any success in the next course.

In 2014, two students with a "D" grade in Biol 220 went on to receive a grade of "F" in BIOL 221 out of a class of 11 students.