Wright College
Physical Science & Engineering
Assessment Project 2016/2017

WHAT?

This project will gather information on student digital literacy in an effort to understand how Wright College (and the Physical Science & Engineering department specifically) addresses General Education SLO #3:

> "Demonstrate quantitative and technological literacy, especially computer literacy, for interpreting data, reasoning, and problem-solving."

This project will assess whether and how our classes are addressing this SLO rather than assessing student performance.

WHY?

The Assessment Committee of Wright College is continuing with a multi-year assessment of the college's general education student learning outcomes. The information will be used to benchmark student results for SLO #3 and allow us to develop internal targets for improvements.

HOW?

A subset of questions from the 2014 Community College Survey of Student Engagement (CCSSE) were selected for their applicability to SLO #3. Using questions from the CCSSE allows us to compare our results with those from across the state and Hispanic-serving national cohorts. The 12-question survey created by the Assessment Committee (see attached) is designed to be given to any class in the college, though not every question would be relevant for every class (e.g. questions concerning multiple drafts of papers are not likely relevant for science classes). The survey was placed on-line and URL links to the survey were provided to each department.

WHAT WE FOUND

Fall 2016 Survey

At the end of the Fall 2016 semester every instructor in the Physical Science & Engineering department was asked to post the survey on the Blackboard site for each of their classes. The results were returned to assessment coordinators at the end of January 2017 (see attached).

In our department, a total of 183 students provided responses to the survey. I estimate that our results have a confidence interval of less than 7% (for a confidence level of 95%). This estimate should not be taken too seriously since our sample is not truly random. It favors classes whose instructors pushed the survey and students who frequented Blackboard. However, the survey responses show that every or nearly every course was covered (including chemistry, physics, astronomy, and physical science).

Key findings:

- A strong majority of the students surveyed responded that they used Blackboard “very often” and that it was “very important” for their science class (questions #9 and #12, 65.7% and 67.2%, respectively). Obviously since the survey was linked from Blackboard, these responses have significant selection bias.

- A small majority responded that they “worked on a paper or a project that required integrating ideas of information from various sources” at least “more than once” (#2, 56.9%). Significantly, 27.9% responded “not at all” to this question. This question likely has broad applicability across nearly every class in every department. For 2014 CCSSE, students across Illinois and from other Hispanic-serving institutions across the nation responded with slightly higher majorities for at least “more than once” (63.3% and 64.4%, respectively). Wright College as a whole responded with 63.7% for at least “more than once”.

- Most responded that they used information they read or heard to perform a new task at least “often” (#4, 78.3%). Only 2.8% responded “never” to this question.

- Most responded that their science class encouraged them to use computers and information technology at least “often” (#5 and #6).

- Most responded that their science class encouraged them to solve problems numerically at least “often” (#7, 69.4%). Note that not all classes in our department emphasize numerical problem-solving (e.g. Astronomy 201 does not even have a math prerequisite).

- A small majority responded that they “used the internet or instant messaging to work on an assignment” at least “often” (#3).

Question #1 asks about the use of multiple drafts in preparing papers, an activity less relevant for science classes. Questions #8, #10, and #11 deal with computer lab use and less about assessing our classes.

Spring 2017 Assessment Project

As a department we felt that the above results indicated relative strength in this SLO, at least as far as the assessment could determine. To build on this strength we decided to experiment with analyzing data collected by students in laboratory classes to find common mistakes or problems with methodology. The aim is to find ways to more directly address student problems when collecting and interpreting data.

We chose Benito Kalaw's Chemistry 201 class as a first demonstration with hopes that our results might lead other lab classes to perform similar analyses. Data was collected from students for two labs which required careful or difficult quantitative measurements which might be ripe for improvements.

<u>Lab: “Spectrophotometric Analysis of Commercial Aspirin”</u>

For the first lab, students determined the amount of aspirin contained within sample solutions using a spectrophotometer (a device for measuring the amount of light absorbed by a solution). This lab required students to 1) carefully calibrate the instrument, 2) identify how different aspirin concentrations related to light absorbance (the Beer's law plot), and 3) measure the absorbance of an unknown solution to find the aspirin concentration. The absorbance measurements for each student group were recorded in a spreadsheet and analyzed (see attached).

The absorbance measurements used to make the Beer's law plots (Part 2) were analyzed to see how well they fit to a straight line (the relationship

between absorbance and concentration should be linear and intercept the y-axis at zero). Student measurements widely varied in quality, but Group #13 seem to have the best results: a high coefficient of determination (RSQ) and an intercept near zero. Their measurements in Part 3 were also found to be close to the expected values (see “% Variance”). For other groups which showed poorer measurements there did not appear to be a clear pattern (e.g. more values high compared to low).

In Part 3, students performed the same test in three trials, preparing identical solutions. For the most part groups found the same results in all three trials even if the results were significantly high or low. This might suggest consistently poor methodology or that students are not preparing new solutions for each trial (as they should be). One possible mistake may be that some are not orienting the cuvettes (test tubes) the same way during each spectrophotometer test which can affect the measured absorbances (when oriented differently the light passes through different glass faces). Another possible mistake is that students are not preparing the solutions correctly as required by the procedure. The components must be added in a specific order otherwise the results are unpredictable. If a group consistently prepared the solutions in the wrong sequence they could get a poor Beer's law plot and poor measurements of the unknown. Stressing to students the importance of the sequence in which the solutions are prepared may improve both parts of the experiment.

Finally, students do not use a computer to find the line that best fits the data, instead drawing the line by hand while eyeballing it. Some improvement part 3 may be found by asking students to plot their data in Excel and using a linear regression to find the best fit.

<u>Lab: “Molar Mass of a Vapor”</u>

In this lab, students measure the molar mass of a liquid using the ideal gas law. They place a small sample of the liquid (unknown to them) in a nearly enclosed flask and raise it to a high temperature which allows the liquid to completely evaporate (the flask is submerged in boiling water). By the time the liquid has completely evaporated, the vapor has pushed out any air inside the flask. When cooled, the vapor that fills the flask condenses back into a liquid. By measuring the mass of the leftover liquid, the volume of the flask, and the temperature and pressure the vapor was at, the molar mass of the liquid can be calculated. All of these measurements were recorded in a spreadsheet and analyzed (see attached).

Interestingly, most groups measured molar masses which were too low (see "% Variance"). Measured temperatures, pressures, and volumes were very similar between groups (volumes varied some, but because significantly different flasks were used). This suggests a problem with the mass measurements. If students are not careful to remove the flask soon after the liquid has fully evaporated, then there will be increased leakage of the vapor and therefore a lower measure mass. The problem is that it can be difficult to see whether any liquid is left in the flask when it is submerged in a beaker of boiling water. A colored solution might make this easier.

Conclusions

These analyses were performed for just two labs for one chemistry course, but the goal is also to demonstrate the value for improving our lab classes across the department. We would like to encourage other instructors to work together to analyze their students' data to find ways to improve experiment methods or preparation.

CITY COLLEGES of CHICAGO
Wilbur Wright
Education that Works

Default Question Block

ADD A BRIEF DESCRIPTION OF THIS SURVEY HERE****

What course are you taking this survey for?
(e.g. English 101, Biology 121, Math 125)

Only enter one course below. *As a reminder, you may be asked to take this survey for other courses you are enrolled in this semester. The following questions should only pertain to the course you enter below:*

1. Prepared two or more drafts of a paper or an assignment before tuning it in.

- Regularly
- More than Once
- Once
- Not at All

2. Worked on a paper or a project that required integrating ideas or information from various sources.

- Regularly
- More than Once
- Once
- Not at All

3. Used the Internet or instant messaging to work on an assignment.

- Very Often
- Often
- Sometimes
- Never

4. Used information you have read or heard to perform a new task.

- Very Often
- Often
- Sometimes
- Never

5. How has this class encouraged you to use computers in academic work.

- Very Often
- Often
- Sometimes
- Never

6. How has this class encouraged you to use computing and information technology?

- Very Often
- Often
- Sometimes
- Never

7. How has this class encouraged you to solve problems numerically?

- Very Often
- Often
- Sometimes

- Never

8. How often do you use the computer lab for your work in this class?

- Very Often
- Often
- Sometimes
- Never

9. How often do you use the learning management services (Blackboard) available to you for this class?

- Very Often
- Often
- Sometimes
- Never

10. How satisfied are you with the computer labs available to you for work necessary to perform in this class?

- Satisfied
- Somewhat Satisfied
- Barely Satisfied
- Not at All Satisfied

11. How important are the computer lab services to you for this class?

- Very Important
- Important
- Somewhat Important
- Not at All Important

12. How important are the learning management services (Blackboard) available to you for this class?

- Very Pmportant
- Important
- Somewhat Important
- Not at All Important

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	
	38	68	63	88	73	69	84	29	117	99	53	119	
	34	36	36	53	48	48	39	25	40	52	47	38	
	21	28	60	34	37	39	34	33	13	11	35	15	
	90	51	24	5	22	24	21	91	8	15	42	5	
N=	183	183	183	180	180	180	178	178	178	177	177	177	
%	20.8%	37.2%	34.4%	48.9%	40.6%	38.3%	47.5%	16.3%	65.7%	55.9%	29.9%	67.2%	
	18.6%	19.7%	19.7%	29.4%	26.7%	26.7%	21.9%	14.0%	22.5%	29.4%	26.6%	21.5%	
	11.5%	15.3%	32.8%	18.9%	20.6%	21.7%	19.1%	18.5%	7.3%	6.2%	19.8%	8.5%	
	49.2%	27.9%	13.1%	2.8%	12.2%	13.3%	11.8%	51.1%	4.5%	8.5%	23.7%	2.8%	

2014 Benchmark (IL)

21.6%	26.0%	38.7%	28.0%	47.0%	27.6%	22.6%	32.6%		45.2%		
29.2%	37.3%	30.2%	36.2%	32.1%	32.6%	32.8%	31.4%	NA	27.9%		NA
28.3%	26.1%	23.0%	28.1%	15.7%	26.5%	29.1%	24.1%		5.4%		
20.9%	10.6%	8.1%	7.7%	5.2%	13.3%	15.5%	11.9%		21.6%		

Percentage Above/Below vs. 2014 Benchmark (IL)

-0.8%	11.2%	-4.3%	20.9%	-6.4%	10.7%	24.9%	-16.3%		10.7%	
-10.6%	-17.6%	-10.5%	-6.8%	-5.4%	-5.9%	-10.9%	-17.4%	NA	1.5%	NA
-16.8%	-10.8%	9.8%	-9.2%	4.9%	-4.8%	-10.0%	-5.6%		0.8%	
28.3%	17.3%	5.0%	-4.9%	7.0%	0.0%	-3.7%	39.2%		-13.1%	

2014 Benchmark (HSI)

21.6%	26.9%	41.5%	28.6%	48.0%	30.4%	24.4%	31.4%		44.2%	
30.0%	37.5%	30.1%	36.2%	31.8%	32.8%	34.2%	30.9%	NA	28.6%	NA
29.2%	26.0%	21.4%	27.5%	15.3%	25.4%	27.9%	25.2%		5.3%	
19.8%	9.6%	7.0%	7.7%	4.7%	11.4%	13.5%	12.4%		22.0%	

Percentage Above/Below vs. 2014 Benchmark (HSI)

-0.8%	10.3%	-7.1%	20.3%	-7.5%	7.9%	23.1%	-15.1%		11.7%	
-11.4%	-17.8%	-10.4%	-6.8%	-5.1%	-6.1%	-12.3%	-16.9%	NA	0.8%	NA
-17.7%	-10.7%	11.4%	-8.6%	5.3%	-3.7%	-8.8%	-6.7%		0.9%	
29.4%	18.3%	6.1%	-4.9%	7.5%	1.9%	-1.7%	38.7%		-13.5%	

2014 Internal Target (WC)										
30.4%	28.1%	40.8%	27.9%	49.8%	29.0%	21.8%	40.0%	NA	47.8%	NA
28.5%	35.6%	33.2%	38.9%	33.4%	32.9%	35.2%	32.1%		32.4%	
23.7%	27.1%	20.4%	25.6%	12.6%	24.6%	26.9%	19.8%		3.6%	
17.4%	9.1%	5.5%	7.7%	4.2%	13.5%	16.0%	8.2%		16.3%	
Percentage Above/Below vs. 2014 Internal Target (WC)										
-9.6%	9.1%	-6.4%	21.0%	-9.2%	9.3%	25.7%	-23.7%	NA	8.1%	NA
-9.9%	-15.9%	-13.5%	-9.5%	-6.7%	-6.2%	-13.3%	-18.1%		-3.0%	
-12.2%	-11.8%	12.4%	-6.7%	8.0%	-2.9%	-7.8%	-1.3%		2.6%	
31.8%	18.8%	7.6%	-4.9%	8.0%	-0.2%	-4.2%	42.9%		-7.8%	

Lab 8 – Spectrophotometric Analysis of Commercial Aspirin

	Molarities		**Group**	1	2	3	4	5	6	7	8
Part 2 Concentration of Reagent Grade Aspirin	*0.00044395*	Solution A Absorbance		0.65	0.68	0.51	0.65	0.59	0.53	0.42	0.61
	0.00035516	Solution B Absorbance		0.48	0.54	0.5	0.42	0.45	0.52	0.4	0.5
	0.00026637	Solution C Absorbance		0.33	0.3	0.32	0.34	0.16	0.45	0.25	0.39
	0.00017758	Solution D Absorbance		0.17	0.26	0.21	0.32	0.14	0.29	0.16	0.23
	8.879E-05	Solution E Absorbance		0.21	0.11	0.14	0.02	0.1	0.25	0.11	0.12
		Slope of Beer's plot		***1340.238***	***1599.275***	***1160.038***	***1531.700***	***1452.863***	***889.738***	***968.575***	***1407.813***
		Intercept of Beer's plot		***0.011***	***-0.048***	***0.027***	***-0.058***	***-0.099***	***0.171***	***0.010***	***-0.005***
		RSQ		***0.898***	***0.963***	***0.950***	***0.903***	***0.871***	***0.917***	***0.955***	***0.995***
		Standard error		***0.073***	***0.050***	***0.043***	***0.081***	***0.091***	***0.043***	***0.034***	***0.016***
Part 3 Determination of % Aspirin in Commercial Aspirin	*0.00023307*	Absorbance of diluted commercial asprin solutions	Sample 1	0.23	0.41	0.32	0.24	0.29	0.39	0.4	0.35
	0.00023307		Sample 2	0.24	0.43	0.34	0.27	0.24	0.45	0.4	0.22
	0.00023307		Sample 3	0.21	0.44	0.36	0.38	0.2	0.35	0.38	0.35
			Expected	***0.323375***	***0.32475***	***0.297375***	***0.299***	***0.239625***	***0.378375***	***0.23575***	***0.323125***
			% Variance	***-29.91%***	***31.38%***	***14.33%***	***-0.78%***	***1.55%***	***4.83%***	***66.84%***	***-5.09%***
			% Var vs 13	***-34.35%***	***23.58%***	***-1.52%***	***-14.07%***	***-29.52%***	***14.89%***	***13.93%***	***-11.18%***

P2 Molarity	*0.0008879*
P3 Molarity	*0.0007769*

Lab 8 – Spectrophotometric Analysis of Commerc

	Molarities		**Group**	9	10	11	12	13	*MEAN*	*MEDIAN*	*STDEV*
Part 2 Concentration of Reagent Grade Aspirin	*0.00044395*	Solution A Absorbance		0.8	0.75	0.91	0.53	0.65	*0.637*	*0.650*	*0.131*
	0.00035516	Solution B Absorbance		0.65	0.7	0.62	0.55	0.53	*0.528*	*0.520*	*0.087*
	0.00026637	Solution C Absorbance		0.57	0.54	0.52	0.24	0.38	*0.368*	*0.340*	*0.124*
	0.00017758	Solution D Absorbance		0.5	0.43	0.37	0.16	0.29	*0.272*	*0.260*	*0.111*
	8.879E-05	Solution E Absorbance		0.3	0.29	0.25	0.11	0.12	*0.164*	*0.120*	*0.086*
		Slope of Beer's plot		***1295.188***	***1340.238***	***1768.213***	***1385.288***	***1464.125***			
		Intercept of Beer's plot		***0.219***	***0.185***	***0.063***	***-0.051***	***0.004***			
		RSQ		***0.966***	***0.981***	***0.961***	***0.874***	***0.993***			
		Standard error		***0.039***	***0.030***	***0.058***	***0.085***	***0.019***			
Part 3 Determination of % Aspirin in Commercial Aspirin	*0.00023307*	Absorbance of diluted commercial asprin solutions	Sample 1	0.52	0.53	0.33	0.32	0.33	*0.356*	*0.350*	*0.095*
	0.00023307		Sample 2	0.5	0.55	0.35	0.23	0.36			
	0.00023307		Sample 3	0.45	0.53	0.33	0.32	0.35			
			Expected	***0.520875***	***0.497375***	***0.475125***	***0.271875***	***0.34525***			
			% Variance	***-5.93%***	***7.90%***	***-29.14%***	***6.67%***	***0.41%***			
			% Var vs 13	***41.93%***	***55.44%***	***-2.49%***	***-16.00%***	***0.41%***			

Lab 9 – Molar Mass of a Vapor

Group		1-unk3	2-unk6	3-unk6	4-unk1	5-unk1	6-unk3	7-unk3	8-unk2	9-unk2
weight flask +cap+rubber band		116.9	121.09	121.19	83.66	83.66	67.65	67.55	90.87	81.78
Temp of boiling water, ^{O}C		103.5	93	95	98	103	100	100	100	100
Barometric pressure, mmHg		756.5	756.5	756.5	765.5	765.5	756.5	756.5	756.5	756.5
weight flask +cap+rubber band+condensed vapor		117.64	121.92	121.74	84.01	84.16	68.19	68.17	91.27	82.05
Volume of flask,ml		255	255	300	255	272	269	270	285	273
Molar mass of vapor, g/mol (reported by students)		90	98	58	42	56	84	81	43.2	30.4
Molar mass of vapor, g/mol	***Calculated***	***90.12***	***98.26***	***55.65***	***41.51***	***56.34***	***61.76***	***70.65***	***43.18***	***30.43***
	Expected	***86.18***	***86.18***	***86.18***	***58.08***	***58.08***	***86.18***	***86.18***	***46.07***	***46.07***
	% Variance	***4.57%***	***14.02%***	***-35.43%***	***-28.53%***	***-2.99%***	***-28.33%***	***-18.02%***	***-6.27%***	***-33.95%***

Lab 9 – Molar Mass of a Vapor

	Group	10-unk2	10-unk2	12-unk5	13-unk5	14-unk4	15-unk4	16-unk1	16-unk1	17-unk7
weight flask +cap+rubber band		93.97	93.97	118.88	102.53	84.91	73.98	86.6	82.99	84.91
Temp of boiling water, ^{O}C		90	94	101	98	95	98	97	98	95
Barometric pressure, mmHg		756.5	756.5	756.5	756.5	756.5	756.5	756.5	756.5	756.5
weight flask +cap+rubber band+condensed vapor		94.33	94.47	119.3	103.5	85.23	74.48	86.78	83.27	85.23
Volume of flask,ml		255	255	268	268	266	279	270	270	274
Molar mass of vapor, g/mol (reported by students)		42	59	48.2	110.1	38.88	61	20	31	35
Molar mass of vapor, g/mol	***Calculated***	***42.27***	***59.36***	***48.35***	***110.76***	***36.52***	***54.84***	***20.35***	***31.74***	***35.45***
	Expected	***46.07***	***46.07***	***46.07***	***46.07***	***58.08***	***58.08***	***58.08***	***58.08***	***46.07***
	% Variance	***-8.25%***	***28.84%***	***4.94%***	***140.42%***	***-37.13%***	***-5.57%***	***-64.97%***	***-45.36%***	***-23.05%***

Lab 9 – Molar Mass of a Vapor

	Group	18-unk7	19-unk6	20unk-6	21-unk5	22-unk5	23-unk4	24-unk4
weight flask +cap+rubber band		73.98	82.7	82.7	94.57	94.57	81.27	81.27
Temp of boiling water, ^{O}C		98	100	100	101	99	99	97.5
Barometric pressure, mmHg		756.5	756.5	756.5	756.5	756.5	756.5	756.5
weight flask +cap+rubber band+condensed vapor		74.48	83.06	83.12	94.85	94.87	81.59	81.64
Volume of flask,ml		272	275	275	265	266	271	271
Molar mass of vapor, g/mol (reported by students)		56	31	31	33	35	37	41
Molar mass of vapor, g/mol	***Calculated***	***56.25***	***40.28***	***46.99***	***32.60***	***34.61***	***36.23***	***41.72***
	Expected	***46.07***	***86.18***	***86.18***	***46.07***	***46.07***	***58.08***	***58.08***
	% Variance	***22.10%***	***-53.26%***	***-45.48%***	***-29.25%***	***-24.88%***	***-37.62%***	***-28.16%***