Assessing Student Learning Across Delivery Modes in Chemistry

Betsy J. Bannier, Kory Boehmer, Cindy Brown, Lloyd Halvorson, Brandi Nelson, and Tammy Riggin
Lake Region State College, Devils Lake ND USA
Email: {Betsy.Bannier, kory.boehmer, cindy.m.brown, lloyd.halvorson, brandi.nelson, tammy.riggin}@lrsc.edu

***Abstract*—A comprehensive statistical analysis of shared assessments was conducted using student assessment data (*n=152*) gathered over a three-semester cycle from three general education chemistry courses taught both online and on-campus at a public, two-year community college in the upper Midwest United States. Item difficulty values, item discrimination values, difficulty ratios were used to evaluate the efficacy of the shared assessment instruments in assessing student learning toward intended course outcomes. Two-sample t-tests were conducted to determine the statistical significance of differences in assessment means by course delivery mode.**

***Index Terms*—accreditation, assessment, chemistry, course outcomes, general education**

I. Introduction

Assessing Student Learning Across Delivery Modes in Chemistry represents the first branch of a four-year project developed by the assessment team at Lake Region State College (LRSC) to meet documented assessment needs. Establishing and evaluating assessment plans at the course, department, program, and institutional levels is essential for higher education institutions seeking accreditation in the United States through accrediting bodies such as the Higher Learning Commission [1]-[3].

Assessing learning of course competencies across delivery modes was critically important due to the diversity of both our delivery modes and our students. Only 39% of total student enrollment at LRSC is accounted for by geographically local students accessing traditional on-campus, face-to-face course delivery. Another 28% of the institution's total student enrollment is accounted for by students living throughout and beyond the United States, seeking fully online course delivery. North Dakota high school students seeking dual credit account for 15% of enrollment, while students at a satellite campus on Grand Forks Air Force Base (AFB) account for 11%. Even this does not paint a complete picture, as 7% of LRSC's total student enrollment is divided between in-state video network courses, a "Launch" program at a nearby flagship university, and nursing programs located off-campus [4]. As a comprehensive community college, Lake Region State College welcomes students from countless locations, sometimes for a full degree program but often for only one or two transfer courses. In this sense, students and their home institutions are all stakeholders in the success of the institution.

Distance education quality is currently the focus of several government initiatives, both on a national scale and within the home state of LRSC. For this reason, the project's focus upon learning across delivery modes is particularly relevant now. Recently, the U.S. Department of Education's negotiated rulemaking committee met to decide upon dozens of policy issues pertinent to online educators and to institutions offering online courses and programs [5]. National policy foci include, but are not limited to, defining regular and substantive interactive in online environments, and maintaining academic integrity. Evaluating student mastery of course outcomes in non-traditional environments serves these additional purposes.

Through the first branch of this project, statistical analysis has demonstrated consistency in student mastery of course competencies across delivery modes in two general chemistry courses. To achieve this outcome, instructors teaching the same chemistry courses using different delivery modes developed and administered common course assessments. Instructors then collaborated with the institutional assessment team to analyze the data and correct inconsistencies on a semester-by-semester basis.

II. Phase I

During the fall 2015 semester, two chemistry instructors jointly developed multiple choice instruments to assess student mastery of course competencies in two courses, Introduction to Organic and Bio-Chemistry and General Chemistry II. Each of these courses are offered in both an online format and an on-campus, face-to-face format every spring semester.

In Spring 2016 the assessment instrument was administered to all 70 students enrolled in either Introduction to Organic and Bio-Chemistry (Chemistry 116) or General Chemistry II (Chemistry 122). A total of 53 students enrolled in Chemistry 116 completed the assessment; six were enrolled in the on-campus section, while 47 were enrolled in the online sections. A total of 17 students enrolled in Chemistry 122; 12 were enrolled in the on-campus section, while 5 were enrolled in the online section.

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A comprehensive item analysis of Spring 2016 assessment data from Chemistry 116 and Chemistry 122 was conducted. First, descriptive statistics were examined at both the exam level and item level for each course format within each course. Descriptive statistics included mean assessment score and standard deviation, as well as item level difficulty and discrimination values. Of particular interest for the purposes of this project were the item level difficulty values, which indicate the proportion of students who answered each item correctly. Item level difficulty values ≤ 0.25 were flagged as being particularly difficult for the sample of students assessed. On the Chemistry 116 assessment, eight items were flagged for further analysis. On the Chemistry 122 assessment, five items were flagged for further analysis. See Fig. 1 and Fig. 2.

Chem 116													
	Format		15 wk day			15 wk on1		15 wk on2		15 wk onAv			
	n		6			24		23		47			
		Outcome Assessed	Difficulty	Discrim	Difficulty Ratio per Outcome (Ratio of assessment items less than or equal to 0.25 difficulty, per outcome)	Difficulty	Discrim	Difficulty	Discrim	Difficulty	Discrim	Difficulty Ratio per Outcome (Ratio of assessment items less than or equal to 0.25 difficulty, per outcome)	
1		1	0.67	0.79	1 = 0.25	0.88	0.18	0.91	0.05	0.89	0.12	1=0	
2		1	0.67	0.79	2 = 0.2	0.96	0.45	1	0	0.98	0.23	2=0	
3		2	1	0	**3 = 0.6**	1	0	1	0	1.00	0.00	3=0	
4		5	0.17	0.75	4 = 0	0.67	0.67	0.78	0.49	0.72	0.58	4=0	
5		3	0.17	0.25	**5 = 0.5**	0.79	0.52	0.91	0.43	0.85	0.48	5=0	
6		3	0	0		0.88	0.32	0.87	0.67	0.88	0.49		
7		4	0.67	0.79		0.92	0.27	0.96	0.16	0.94	0.22		
8		4	0.67	0.4		0.96	0.15	0.83	0.45	0.90	0.30		
9		1	1	0		0.96	0.45	1	0	0.98	0.23		
10		5	0.83	0.25		0.96	0.15	1	0	0.98	0.08		
11		1	0.17	0.25		0.54	0.63	0.39	0.37	0.47	0.50		
12		2	1	0		0.71	0.72	0.65	0.41	0.68	0.57		
13		3	0.2	0.39		0.71	0.46	0.48	0.45	0.60	0.46		
14		2	0.67	0.79		1	0	1	0	1.00	0.00		
15		5	0.17	0.25		0.92	0.49	0.91	0.56	0.92	0.52		
16		2	0.67	0.4		1	0	0.91	0.02	0.96	0.01		
17		5	1	0		0.79	0.11	0.91	0.02	0.85	0.07		
18		3	0.33	0		1	0	0.91	0.56	0.96	0.27		
19		2	0.5	0.56		0.63	0.03	0.52	0.02	0.58	0.03		
20		2	1	0		1	0	1	0	1.00	0.00		
21		2	0.67	0.4		0.5	0.42	0.52	0.27	0.51	0.35		
22	*2		0.33	0.2		0.25	0.21	0.22	0.02	0.24	0.12		
23		3	0.17	0.5		0.75	0.45	0.74	0.5	0.75	0.47		
24		2	0.17	0.75		0.25	0.42	0.43	0.56	0.34	0.49		
25		2	0.17	0.25		1	0	1	0	1.00	0.00		
			mean	52		mean	80		79		80		
			stdev	7.15		stdev	11.13		9.67		10.42		
			n	6		n	24		23		47		
		*Suspect discrimination value; item discarded											

Figure 1. Chemistry 116 initial data and highlighted areas of concern.

Chem 122												
	Format		15 wk day			15 wk onl						
	n		12			5						
		Outcome assessed	Difficulty	Discrim	Difficulty Ratio per Outcome (Ratio of assessment items less than or equal to 0.25 difficulty, per outcome)	Difficulty	Discrim	Difficulty Ratio per Outcome (Ratio of assessment items less than or equal to 0.25 difficulty, per outcome)			Avg Dif	Avg Discr
1	3		0.17	0.49	1 = 0.25	0.8	0.52	**1 = 0.25**			0.36	0.50
2	*6		0.08	0.17	2 = 0	0.8	0.52	2 = 0			0.29	0.27
3	4		0.17	0.25	3 = 0.5 (1/2 items)	1	0	3 = 0			0.41	0.18
4	4		0.5	0.5	**4 = 0.5 (2/4 items)**	0.8	0.52	4 = 0			0.59	0.51
5	2		0.75	0.48	5 = 0	0.8	0.52	5 = 0			0.76	0.49
6	2		0.67	0.29	6 = 0	1	0	6 = 0			0.77	0.20
7	5		0.92	0.5	7 = 0	1	0	7 = 0			0.94	0.35
8	5		0.42	0.56	8 = 0	1	0	8 = 0			0.59	0.40
9	7		0.83	0.8		0.8	0.52				0.82	0.72
10	2		0.75	0.79		0.8	0.52				0.76	0.71
11	8		0.58	0.46		1	0				0.70	0.32
12	1		0.75	0.21		1	0				0.82	0.15
13	n/a		0.75	0.26		0.8	0.35				0.76	0.29
14	4		0.17	0.37		0.4	0.74				0.24	0.48
15	1		0.83	0.25		1	0				0.88	0.18
16	1		0.42	0.09		0.8	0.52				0.53	0.22
17	2		0.42	0.51		0.8	0.13				0.53	0.40
18	2		0.58	0.28		1	0				0.70	0.20
19	4		0.5	0.55		1	0				0.65	0.39
20	3		0.67	0		1	0				0.77	0.00
21	8		0.5	0.46		1	0				0.65	0.32
22	1		0.17	0.31		0.2	0.52				0.18	0.37
23	8		0.25	0.53		1	0				0.47	0.37
24	8		0.5	0.05		0.8	0.52				0.59	0.19
25	8		0.67	0.39		0.8	0.52				0.71	0.43
											All 15 week (Day + Online)	
			mean	55.02		mean	88				mean	64.72
			stdev	13.7		stdev	9.05				Stdev	12.33
			n	12		n	5				n	17
		*Suspect discrimination value; item discarded										

Figure 2. Chemistry 122 initial data and highlighted areas of concern.

Second, item discrimination values were examined for each of the assessment items flagged in Step 1, above. Item discrimination is a comparative measure of the proportion of high-scoring students who answered an item correctly relative to the proportion of low-scoring students who answered the item correctly. Discrimination values of less than 0.20 bring the assessment item itself into question, and were flagged for further analysis [6]. Of the thirteen items

with difficulty values ≤ 0.25, two had discrimination values of less than 0.20. These two items were discarded from analysis of outcome mastery.

Third, assessment items were labeled according to the course competencies they primarily measure. After labeling each assessment item with its corresponding course competency, difficulty ratios per outcome were calculated. These values represent the ratios of assessment items less than or equal to 0.25 difficulty, per outcome. As seen in Fig. 3 and Fig. 4, these values offer a straightforward way of quantitatively identifying course competencies which should be the focus of further curriculum development.

Chem 116																		
	Format		15 wk onAv 2017						15 wk online Spring 2018									
	n		47								Sect18341		Section18342		15 wk onAv 2018			
		Outcome Assessed	Difficulty	Discrim	Difficulty Ratio per Outcome (Ratio of assessment items less than or equal to 0.25 difficulty, per outcome)	Avg Dif 2	Avg Discr 2017		Difficulty	Discrim	Difficulty	Discrim	Difficulty	Discrim	Difficulty Ratio per Outcome (Ratio of assessment items less than or equal to 0.25 difficulty, per outcome)	
	1	1	0.89	0.12	1 = 0	0.84	0.30		0.82	0.44	1	0	0.88	0.30	1 = 0	
	2	1	0.98	0.23	2 = 0.1	0.90	0.52		0.12	-0.16	0.63	0.21	0.28	-0.04	2 = .2	
	3	2	1.00	0.00	3 = 0	1.00	0.00		0.76	0.08	0.75	0.52	0.76	0.22	3 = 0	
	4	5	0.72	0.58	4 = 0	0.57	0.69		0.71	0.53	1	0	0.80	0.36	4 = 0	
	5	3	0.85	0.48	5 = 0	0.67	0.47		0.82	0.33	0.75	-0.22	0.80	0.15	5 = 0	
	6	3	0.88	0.49		0.70	0.26		1	0	0.63	0.42	0.88	0.13		
	7	4	0.94	0.22		0.87	0.37		0.88	0.55	0.88	0.58	0.88	0.56		
	8	4	0.90	0.30		0.90	0.20		0.88	0.29	1	0	0.92	0.20		
	9	1	0.98	0.23		0.97	0.36		0.71	0.43	0.75	0.4	0.72	0.42		
	10	5	0.98	0.08		0.93	0.17		0.65	0.49	0.75	0.04	0.68	0.35		
	11	1	0.47	0.50		0.47	0.55		1	0	1	0	1.00	0.00		
	12	2	0.68	0.57		0.77	0.58		0.65	0.22	0.38	0.56	0.56	0.33		
	13	3	0.60	0.46		0.61	0.45		0.88	0.42	0.88	0.1	0.88	0.32		
	14	2	1.00	0.00		0.93	0.16		0.65	0.35	0.5	0.89	0.60	0.52		
	15	5	0.92	0.52		0.77	0.44		0.82	0.06	0.88	0.42	0.84	0.18		
	16	2	0.96	0.01		0.93	0.08		0.94	0.06	1	0	0.96	0.04		
	17	5	0.85	0.07		0.83	0.09		0.59	0.46	1	0	0.72	0.31		
	18	3	0.96	0.27		0.87	0.00		0.94	0.51	0.88	0.58	0.92	0.53		
	19	2	0.58	0.03		0.60	0.14		0.06	0.13	0.13	0.54	0.08	0.26		
	20	2	1.00	0.00		1.00	0.00		0.47	0.42	1	0	0.64	0.29		
	21	2	0.51	0.35		0.53	0.42		0.53	0.22	0.88	0.1	0.64	0.18		
	22	2	0.24	0.12		0.27	0.21		0.12	0.25	0.38	0.45	0.20	0.31		
	23	3	0.75	0.47		0.63	0.46		0.35	0.45	0.88	-0.38	0.52	0.18		
	24	2	0.34	0.49		0.23	0.49		0.41	0.11	0.75	0.52	0.52	0.24		
	25	2	1.00	0.00		0.83	0.05		0.88	0.35	1	0	0.92	0.24		
						All 15 week 2017 (Day + Online)							All 15 week 2018 (All online)			
				80		mean	76.40			67		79		70.84		
				10.42		Stdev	10.05			11.5		10.2		11.084		
				47		n	53			17		8		25		

Figure 3. Chemistry 116 end-of-cycle data.

Chem 122																						
	Format		15 wk day SP17			15 wk day SP18			15 wk onl SP17			15 wk onl SP18										
	n		12			7			5			21										
		Outcome assessed	Difficulty	Discrim	Difficulty Ratio per Outcome (Ratio of assessment items less than or equal to 0.25 difficulty, per outcome)2017	Difficulty	Discrim	Difficulty Ratio per Outcome (Ratio of assessment items less than or equal to 0.25 difficulty, per outcome)2018	Difficulty	Discrim	Difficulty Ratio per Outcome (Ratio of assessment items less than or equal to 0.25 difficulty, per outcome)2017	Difficulty	Discrim	Difficulty Ratio per Outcome (Ratio of assessment items less than or equal to 0.25 difficulty, per outcome)2018		Avg Dif2017	Avg Discr2017	Avg Dif 2018	AvgDiscr2018
	1	3	0.17	0.49	1 = 0.25	0.29	0.45	1 = 0	0.8	0.52	1 = 0.25	0.75	0.45	1 = 0.25		0.36	0.50	0.635	0.45
	2	6	0.08	0.17	2 = 0	0.57	0.26	2 = 0	0.8	0.52	2 = 0	0.9	0.3	2 = 0		0.29	0.27	0.705	0.29
	3	4	0.17	0.25	3 = 0.5 (1/2 items)	0.43	0.02	3 = 0	1	0	3 = 0	0.9	0.61	3 = 0		0.41	0.18	0.67	0.4625
	4	4	0.5	0.5	4 = 0.5 (2/4 items)	0.86	0.16	4 = 0.25	0.8	0.52	4 = 0	0.95	0.22	4 = 0		0.59	0.51	0.7775	0.125
	5	2	0.75	0.48	5 = 0	1	0	5 = 0	0.8	0.52	5 = 0	1	0	5 = 0		0.76	0.49	0.8125	0
	6	2	0.67	0.29	6 = 1.0 (1/1 items)	1	0	6 = 0	1	0	6 = 0	1	0	6 = 0		0.77	0.20	0.8125	0
	7	5	0.92	0.5	7 = 0	0.57	0.74	7 = 0	1	0	7 = 0	0.95	0.22	7 = 0		0.94	0.35	0.705	0.02
	8	5	0.42	0.56	8 = 0	0.86	0.16	8 = 0	1	0	8 = 0	0.9	0.4	8 = 0.2		0.59	0.40	0.7775	0.34
	9	7	0.83	0.8		1	0		0.8	0.52		0.9	0.61			0.82	0.72	0.8125	0.4575
	10	2	0.75	0.79		1	0		0.8	0.52		1	0			0.76	0.71	0.8125	0
	11	8	0.58	0.46		0.71	0.24		1	0		0.1	0.42			0.70	0.32	0.74	0.375
	12	1	0.75	0.21		0.86	0.16		1	0		0.9	0.2			0.82	0.15	0.7775	0.19
	13	n/a	0.75	0.26		1	0		0.8	0.35		1	0			0.76	0.29	0.8125	0
	14	4	0.17	0.37		0.14	0.63		0.4	0.74		0.6	0.11			0.24	0.48	0.5975	0.24
	15	1	0.83	0.25		0.29	0.37		1	0		0.66	0.09			0.88	0.18	0.635	0.025
	16	1	0.42	0.09		0.86	0.05		0.8	0.52		0.8	0.3			0.53	0.22	0.7775	0.2125
	17	2	0.42	0.51		0.71	0.84		0.8	0.13		0.9	0.4			0.53	0.40	0.74	0.51
	18	2	0.58	0.28		0	1		1	0		1	0			0.70	0.20	0.5625	0.25
	19	4	0.5	0.55		0.86	0.55		1	0		1	0			0.65	0.39	0.7775	0.1375
	20	3	0.67	0		0.29	0.37		1	0		0.7	0.23			0.77	0.00	0.635	0.08
	21	8	0.5	0.46		0.71	0.84		1	0		0.9	0.51			0.65	0.32	0.74	0.5925
	22	1	0.17	0.31		0.71	0.43		0.2	0.52		0.05	0.22			0.18	0.37	0.74	0.2725
	23	8	0.25	0.53		0.71	0.84		1	0		0.95	0.35			0.47	0.37	0.74	0.4725
	24	8	0.5	0.05		0.57	0.6		0.8	0.52		0.75	0.73			0.59	0.19	0.705	0.6975
	25	8	0.67	0.39		1	0		0.8	0.52		0.95	0.21			0.71	0.43	0.8125	0.1575
																All 15 week 2017 (Day + Online)		All 15 week 2018 (Day + Oni	
			mean	55.02		mean	80		mean	88		mean	83			mean	64.72	mean	82.25
			stdev	13.7		stdev	14.6		stdev	9.05		stdev	11.8			Stdev	12.33	Stdev	12.5
			n	12		n	7		n	5		n	21			n	17	n	28

Figure 4. Chemistry 122 end-of-cycle data.

In Chemistry 116 course competency #3 was identified as the focus of further curriculum development. In Chemistry 122, course competencies #1 and #4 were identified as the curriculum development focus. These course competencies are as follows:

- Chemistry 116 outcome #3: Students who successfully complete Chemistry 116 will possess a fundamental understanding of biochemistry concepts of structure-function relationships, enzymes, nucleic acids, and energy generation.

- Chemistry 122 outcome #1: Students who successfully complete Chemistry 122 will possess an understanding of intermolecular forces, including how such forces affect bulk properties, and an understanding of the properties of different phases of matter.
- Chemistry 122 outcome #4: Students who successfully complete Chemistry 122 will possess an understanding of chemical equilibrium, including the ability to perform equilibrium calculations on a variety of chemical reactions, including gas phase reactions, acid/base reactions, and solubility product calculations.

III. Phase II

Between Spring 2017 and Spring 2018, curricular changes were developed and implemented by course instructors to address course competency concerns in Chemistry 116 and Chemistry 122. Those changes included an emphasis on the particulate level of understanding through the use of pictorial representations and class discussions focusing on the interactions of molecules using this method. The assessment instrument was administered again, and compared to data from the previous year. As seen in Fig. 5, a statistically significant change was not observed over the same timeframe in Chemistry 116, where assessment scores were already within the expected grade distribution range [7]. However, a statistically significant increase in student mastery of course learning outcomes in Chemistry 122 was seen from the beginning to the end of the two-semester assessment cycle.

Chemistry 116	n	Mean	StDev	SE Mean	Chemistry 122	n	Mean	StDev	SE Mean
2017 Data	53	76.4	10.05	1.3805	2017 Data	17	64.72	12.33	2.9905
2018 Data	25	70.84	11.08	2.216	2018 Data	28	82.25	12.5	2.3623
Two-sample t-test (95% confidence interval) p= 0.039 The difference in means is not statistically significant					Two-sample t-test (95% confidence interval) p< 0.001 The difference in means is statistically significant				

Figure 5. Two-sample t-test findings.

IV. Phase III: Current and Future Steps

Upon completion of one full cycle (assessing, revising curriculum, and reassessing over two non-consecutive semesters) with Chemistry 116 and 121, the same two chemistry instructors developed a shared assessment instrument to be administered in General Chemistry I, Chemistry 121. This assessment was initially administered in Fall 2018. Data was analyzed using the same approach as described earlier for Chemistry 116 and 122. As in Phase 2, descriptive statistics were examined at both the exam level and item level for each course format within each course. Item level difficulty values ≤ 0.25 were again flagged as being particularly difficult for the sample of students assessed. Three items were flagged based upon difficulty values for further examination.

Second, item discrimination values were examined for each of the assessment items flagged in Step 1, above. As seen in Fig. 6, an initial glance at the data suggested a problem with negative discrimination values. Of the three items with difficulty values ≤ 0.25, only one had a negative discrimination value. However, 11 total items from the 63 item assessment had negative average discrimination values. This is a significant concern which will be closely compared with parallel Chemistry 121 data to be obtained during the Fall 2019 semester. It is possible that small sample size combined with several outlier exams was enough to create the negative discrimination values. It is also possible that the assessment items themselves are poorly designed and need to be replaced.

Third, assessment items were labeled according to the course competencies they primarily measure. There are seven competencies in Chemistry 121. After labeling each assessment item with its corresponding course competency, difficulty ratios per outcome were calculated. These values represent the ratios of assessment items less than or equal to 0.25 difficulty, per outcome, and offer a straightforward way of quantitatively identifying course competencies which should be the focus of further curriculum development. Based upon our initial assessment data, course competencies #3 and #4 have been targeted for teaching and learning improvement. These course competencies are as follows:

- Students who successfully complete Chemistry 121 will possess a fundamental understanding of the behavior and properties of ideal gases.
- Students who successfully complete Chemistry 121 will possess an understanding of elementary thermochemistry (Hess' Law calculations, heats of reaction, heats of formation, etc.). gases and thermodynamics. The efficacy of these curricular changes will be evaluated in Fall 2019, using assessment data yet to be collected as of this writing. If problematic trends from the first semester Chemistry 121 assessment item analysis are still present, the assessment will be redesigned.

V. Conclusions

Conclusions are to be considered as snapshots of time rather than final endpoints, as this study is intended to be purposefully ongoing. By continuing the process used for Chemistry 116 and 122 with Chemistry 121 and eventually other disciplines, Lake Region State College is embarking upon a path of continuous improvement. Just as teaching and learning processes are ongoing, dynamic processes,

assessing student achievement of course outcomes across delivery modes should be an ongoing, dynamic endeavor.

Quantitative findings at this point show overall consistent student achievement of intended course outcomes in both Introduction to Organic and Biochemistry (Chemistry 116) and General Chemistry II (Chemistry 122) in both online and on-campus course delivery modes. Student achievement in Chemistry 116 was within a standard curve at the onset of the study. Student achievement in Chemistry 122 left ample room for improvement at the onset of the study, and statistically significant improvement was noted after one semester of purposeful curricular changes.

Chem 121			Chem 121					15 wk online Fall 2018		
	Format		15 wk day Fall 2018							
	n		19					10		
		Outcome Assessed	Difficulty	Discrimination	Difficulty Ratio per Outcome (Ratio of assessment items less than or equal to 0.25 difficulty, per outcome)	Avg Difficulty	Avg Discrimination	Difficulty	Discrimination	Difficulty Ratio per Outcome (Ratio of assessment items less than or equal to 0.25 difficulty, per outcome)
1	2	0.84	0.62	1 = 0.20	0.86	0.70	0.9	0.84	1 = 0
2	1	0.58	0.13	2 = 0.06	0.62	0.33	0.7	0.7	2 = 0
3	1	0.68	0.11	3 = 0.10	0.69	0.31	0.7	0.7	3 = 0.33
4	1	0.37	0.61	4 = 0.25	0.55	0.69	0.9	0.84	4 = 0
5	5	0.37	0.56	5 = 0	0.55	0.66	0.9	0.84	5 = 0
6	1	0.68	0.22	6 = 0.09	0.72	0.42	0.8	0.8	6 = 0
7	2	0.42	0.04	7 = 0.33	0.59	-0.03	0.9	-0.17	7 = 0
8	5	0.58	0.55		0.69	0.44	0.9	0.23	
9	1	0.63	0.4		0.69	0.43	0.8	0.48	
10	1	0.89	-0.26		0.93	-0.51	1	-0.99	
11	2	0.89	0.31		0.93	-0.14	1	-0.99	
12	2	0.58	0.33		0.66	0.41	0.8	0.57	
13	2	0.58	0.39		0.52	0.32	0.4	0.19	
14	1	0.21	0.74		0.38	0.77	0.7	0.84	
15	2	1	-0.99		0.97	-0.36	0.9	0.84	
16	2	0.89	0.12		0.93	-0.26	1	-0.99	
17	1	0.89	0.08		0.89	0.34	0.9	0.84	
18	2	0.74	0.07		0.69	0.19	0.6	0.43	
19	2	0.74	0.07		0.66	0.24	0.5	0.56	
20	2	0.26	0.67		0.31	0.66	0.4	0.64	
21	2	0.32	0.63		0.31	0.58	0.3	0.48	
22	2	0.95	0.03		0.97	-0.32	1	-0.99	
23	5	0.68	0.29		0.69	0.41	0.7	0.64	
24	2	0.89	0.14		0.93	-0.25	1	-0.99	
25	2	0.84	0.31		0.90	-0.14	1	-0.99	
26	6	0.47	0.41		0.55	0.37	0.7	0.3	
27	6	0.37	0.35		0.48	0.45	0.7	0.64	
28	7	0.63	0.56		0.65	0.43	0.7	0.17	
29	6	0.68	0.31		0.69	0.26	0.7	0.17	
30	6	0.32	0.49		0.49	0.38	0.8	0.17	
31	6	0.26	0.7		0.45	0.73	0.8	0.8	
32	6	0.42	0.51		2.69	0.62	7	0.84	
33	3	0.21	-0.33		0.21	-0.27	0.2	-0.17	
34	3	0.79	0.52		0.69	0.49	0.5	0.42	
35	3	0.26	0.49		0.45	0.54	0.8	0.63	
36	3	0.37	0.38		2.66	0.39	7	0.42	
37	3	0.84	0.08		0.83	0.25	0.8	0.57	
38	6	0.26	0.37		0.52	-0.10	1	-0.99	
39	6	0.11	0.47		0.35	0.58	0.8	0.8	
40	6	0.68	0.48		0.72	0.24	0.8	-0.21	
41	6	0.79	0.33		0.79	0.49	0.8	0.8	
42	3	0.63	0.55		0.76	0.02	1	-0.99	
43	3	1	-0.99		1.00	-0.99	1	-0.99	
44	1	0.63	0.5		0.65	0.42	0.7	0.28	
45	6	0.89	0.4		0.89	0.55	0.9	0.84	
46	3	0.79	0.46		0.83	0.59	0.9	0.84	
47	1	0.58	0.13		0.62	0.25	0.7	0.48	
48	1	0.58	-0.21		0.66	0.14	0.8	0.8	
49	2	0.16	0.51		0.42	0.62	0.9	0.84	
50	2	0.84	0.08		0.86	0.13	0.9	0.23	
51	2	0.89	0.12		0.86	0.35	0.8	0.8	
52	3	0.79	-0.06		0.76	0.25	0.7	0.84	
53	3	0.89	0.23		0.89	0.23	0.9	0.23	
54	1	0.16	0.09		0.24	0.25	0.4	0.55	
55	4	0.47	0.48		0.62	0.60	0.9	0.84	
56	4	0.84	0.22		0.83	0.36	0.8	0.63	
57	1	0.37	0.31		0.45	0.32	0.6	0.35	
58	1	0.47	0.23		0.58	0.32	0.8	0.48	
59	7	0.11	0.17		0.28	0.32	0.6	0.6	
60	1	0.21	-0.02		0.41	0.20	0.8	0.63	
61	4	0.05	0.19		0.17	0.32	0.4	0.57	
62	4	0.53	0.34		0.52	0.47	0.5	0.72	
63	7	0.79	0.46		0.79	0.58	0.8	0.8	
				On Campus				Online	
				58.24				76.19	
				12.63				19.02	
				19				10	

Figure 6. Chemistry 122 initial data with highlighted areas of concern

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

All authors worked together as a team throughout the course of this study. Data was gathered and analyzed by Betsy Bannier and Kory Boehmer. Betsy Bannier was the principle author. All authors had approved the final version.

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Betsy J. Bannier earned her Ph.D. in adult & continuing education with an emphasis in online chemistry education at University of Wisconsin – Milwaukee (USA) in 2009. She earned her M.S. in analytical chemistry with a cognate in chemical education at University of North Dakota (Grand Forks, ND USA) in 2000, and her B.A. in mathematics and chemistry at Alverno College (Milwaukee, WI USA) in 1997.

She is a tenured Professor of Chemistry at Lake Region State College in Devils Lake, North Dakota. She has over twenty years of experience teaching in higher education, primarily in the field of undergraduate, online laboratory chemistry. She serves on several national and international review boards and her work has been published in a wide variety of journals. Her current research interests include teaching at the intersection of chemistry and space science, learning strategies in online classrooms, and transnational online education.

Lloyd W. Halvorson earned his M.S. degree (1997) and B.S. degree (1991) in criminal justice from Minot State University (Minot, ND). He holds both a teaching credential and an administrative credential from the ND Department of Career and Technical Education.

After having spent ten years as a police officer, police supervisor, and administrator at the Bismarck (ND) Police Department, Halvorson joined Lake Region State College in Devils Lake, ND as a post-secondary law enforcement instructor and program director. He served as a member of the ND Peace Officer Standards and Training (POST) Board, having been appointed by the ND Attorney General in October, 2003 and served in that capacity for six years. He has served as the Secretary for the International Association of the Directors of Law Enforcement Standards and Training for several years and was a member of that association's Executive Committee. He is currently the Vice President of Academic and Student Affairs at Lake Region State College. He served previously as the Vice President for Academic Affairs, Assistant Vice President of Instructional Services, Tenured Assistant Professor, and Director of Peace Officer Training at the Devils Lake, ND campus.