Sacramento City College
Planning, Research and Institutional Effectiveness (PRIE)
May 2018

THE RELATIONSHIP BETWEEN BIOLOGY COURSE OUTCOMES AND TYPE OF CHEMISTRY PREPARATION FOR ALLIED HEALTH MAJOR

Prepared by Lan Hoang (Research Analyst) and Jay Cull (Senior IT Specialist)

INTRODUCTION

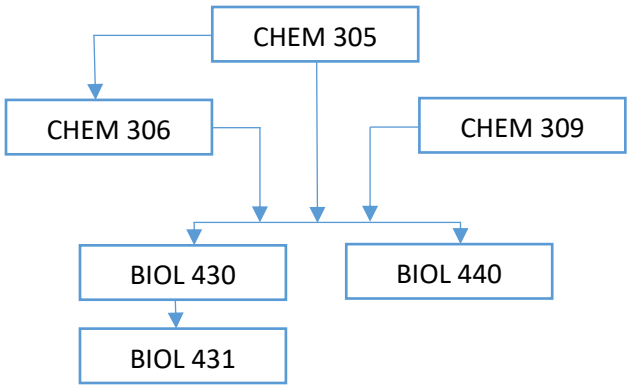
This report is prepared at the request of the Biology and Chemistry Departments at Sacramento City College (SCC) to explore curricular changes in an effort to improve retention and success for Allied Health students. This updated study replicates the 2009 study conducted at American River College by Professor Deboleena Roy, entitled "Evaluation of Chemistry Pre-requisite to Biology courses for Nursing and Allied Health." In this report, we compare student performance in BIOL 430 (Anatomy and Physiology I), BIOL 431 (Anatomy and Physiology II), and BIOL 440 (General Microbiology) by type of Chemistry preparation, i.e. CHEM 305 (Introduction to Chemistry), both CHEM 305 and CHEM 306 (Introduction to Chemistry, and Introduction to Organic and Biological Chemistry), or CHEM 309 (Integrated General, Organic, and Biological Chemistry). Because of the small number of students in the Sacramento City College sample, the report utilizes district-wide data and was conducted in coordination with the Los Rios Community College Office of Institutional Research.[1]

COURSE SEQUENCE AND BIOLOGY COURSE SUCCESS BY TYPE OF CHEMISTRY PREPARATION

Students have to successfully complete either CHEM 305 or CHEM 309, i.e. to receive grade C or better, before enrolling in BIOL 430 or BIOL 440.[2] Students can also choose to complete the CHEM 305 and CHEM 306 sequence (CHEM 305-306) before enrolling in BIOL 430 or BIOL 440. Successful completion of BIOL 430 (receiving grade C or better) is required before enrolling in BIOL 431. Figure 1 on the next page maps the sequence of these CHEM-BIOL courses for Allied Health major.

[1] However, the SCC Research Office (Lan Hoang, SCC research analyst) takes responsibility for the accuracy of the data and analysis in this report.
[2] Students can also enter BIOL 430 or BIOL 440 through successful completion of CHEM 400. However, this report only examines the course sequence typically taken by the Allied Health majors.

Figure 1. CHEM - BIOL course sequence for Allied Health major



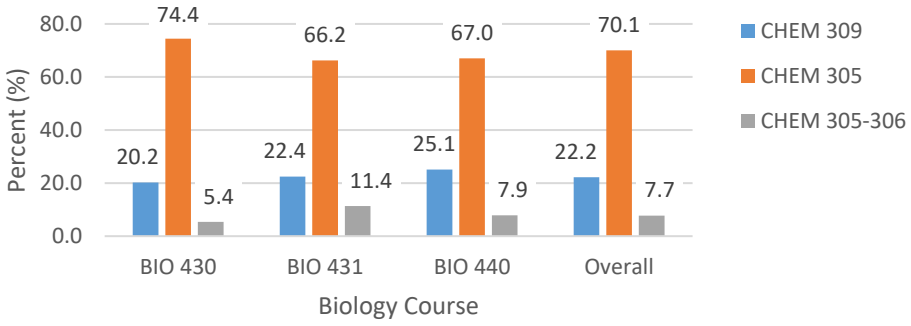
The data include all students who took CHEM 305, CHEM 305-306, or CHEM 309 at any college in the District and subsequently completed BIOL 430, BIOL 431, or BIOL 440 at any college in the District between Fall 2012 and Fall 2017.[3] There are 9,453 students in the sample. Table 1 and Figure 2 below show the distribution of Biology course enrollments by type of Chemistry preparation using the district-wide data described above. The "N" columns show the number of enrollments and the "%" columns show the percentage of the Biology enrollments by each type of Chemistry preparation. The most common pathway to the BIOL courses is through successful completion of CHEM 305 (receiving grade C or better; more than 70% of the students in the sample). Over 22% of the students entered the BIOL courses through successful completion of CHEM 309. Less than 8% of the students in the sample successfully completed both CHEM 305 and 306 before enrolling in the BIOL courses (Table 1 and Figure 2).

Table 1. Distribution of Biology course enrollments by type of Chemistry preparation
District-wide data, Fall 2012 - Fall 2017

Type of CHEM Preparation	BIOL 430		BIOL 431		BIOL 440		Total	
	N	%	N	%	N	%	**N**	**%**
CHEM 309	839	20.2%	584	22.4%	677	25.1%	**2100**	**22.2%**
CHEM 305*	3090	74.4%	1724	66.2%	1808	67.0%	**6622**	**70.1%**
CHEM 305-306	223	5.4%	296	11.4%	212	7.9%	**731**	**7.7%**
Total	**4152**	**100%**	**2604**	**100%**	**2697**	**100%**	**9453**	**100%**

** Note: CHEM 305 count does not include students who completed both CHEM 305 and CHEM 306 (CHEM 305-306).*

Figure 2. Distribution of Biology course enrollments by type of Chemistry preparation
District-wide data, Fall 2012 - Fall 2017



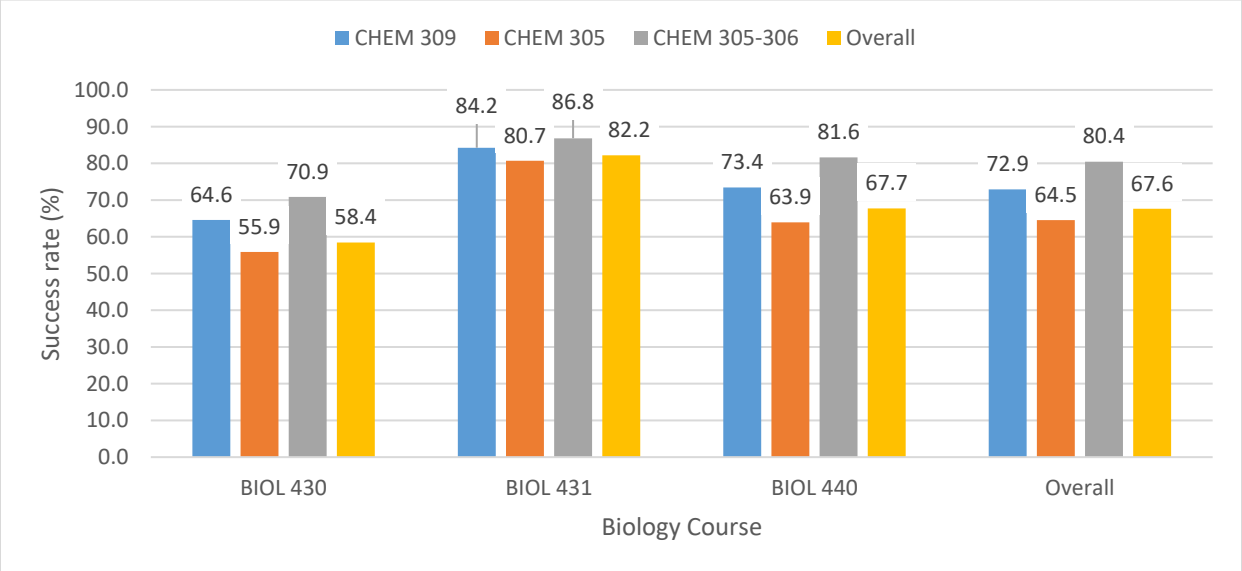
[3] The reason for choosing this period is that there was a change in the date students would receive a W grade when they drop a class, which moved the last date to drop a class without receiving a W-grade to a much earlier date in the semester.

Table 2 and Figure 3 summarize the success rates in the BIOL courses by type of CHEM preparation. Success is defined according to the RP Group's operational definition (2011).[4] To be counted as "Success" in the course, students have to have achieved a grade of A, B, C, or P. Accordingly, success rate is calculated with the numerator being total enrollment with a grade of A, B, C, P and the denominator being total enrollment with a grade of A, B, C, D, F, NP, I and W. The overall success rate in the BIOL courses is 67.6%. Examined by type of CHEM preparation, students who successfully completed both CHEM 305 and 306 seem to be most likely to succeed in the BIOL courses (success rate = 80.4%). Success rate appears to be higher for students who successfully completed CHEM 309 than those who entered BIOL courses through the CHEM 305 pathway (about 73% compared to 64.5%).

Table 2. BIOL course success and success rates by type of CHEM preparation
District-wide data, Fall 2012 – Fall 2017

Type of CHEM Preparation	BIOL 430		BIOL 431		BIOL 440		Total	
	Count of Success	Course Success Rate	Count of Success	Course Success Rate	Count of Success	Course Success Rate	Count of Success	Course Success Rate
CHEM 309	542	64.6%	492	84.2%	497	73.4%	**1531**	**72.9%**
CHEM 305	1726	55.9%	1391	80.7%	1156	63.9%	**4273**	**64.5%**
CHEM 305-306	158	70.9%	257	86.8%	173	81.6%	**588**	**80.4%**
Total	**2426**	**58.4%**	**2140**	**82.2%**	**1826**	**67.7%**	**6392**	**67.6%**

Figure 3. BIOL course success rates by type of CHEM preparation
District-wide data, Fall 2012 – Fall 2017



[4] Research and Planning (RP) Group "Operational Definitions." http://rpgroup.org/Institutional-Research-Operational-Definitions (last retrieved 4/30/2018)

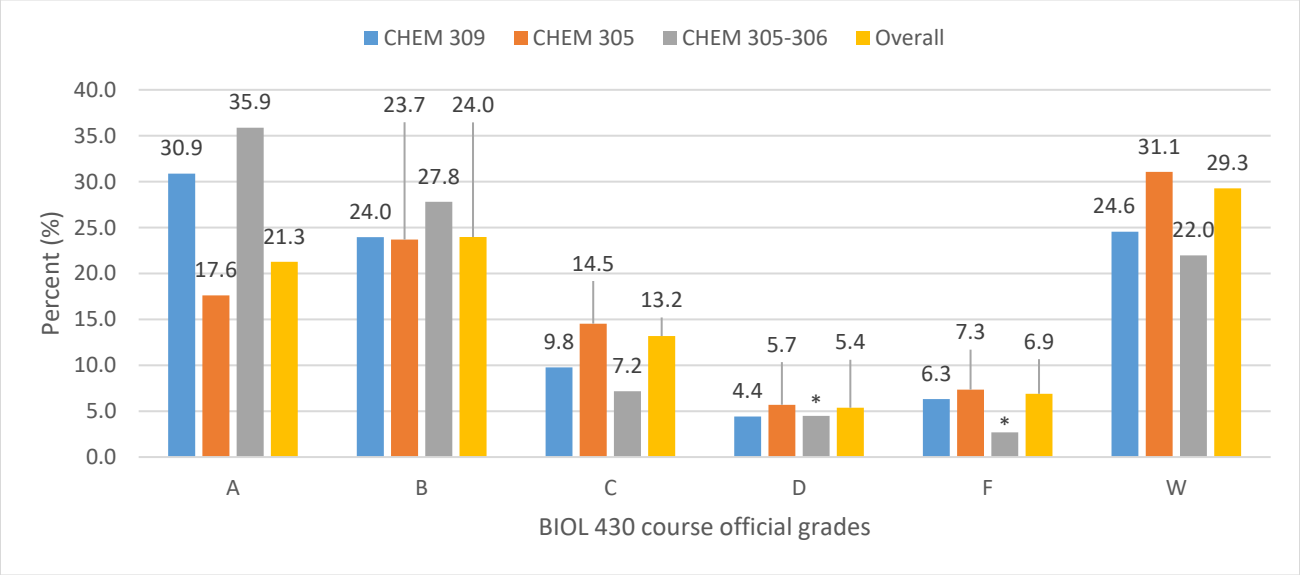
We went further to examine grade distribution in the BIOL courses by type of CHEM preparation. Table 3 to Table 5 and Figure 4 to Figure 6 illustrate grade distribution in the BIOL courses by type of CHEM preparation. Across the BIOL courses, students who enrolled through CHEM 305-306 have the highest proportion of B grades or higher (63.7% in BIOL 430, 75% in BIOL 431, and 71.2% in BIOL 440), followed by CHEM 309 (54.9%, 74.3%, and 60.7%), and CHEM 305 (41.3%, 65.6%, and 51.8%). It is noteworthy that CHEM 305 has the highest proportion of students with W grades in each of the BIOL courses. However, generalizability can be limited due to the small cell sizes for some grade categories, especially in CHEM 305-306.

Table 3. BIOL 430 grade distribution by CHEM course taken
District-wide data, Fall 2012 – Fall 2017

Type of CHEM Preparation	BIOL 430 course official grades													
	A		B		C		D		F		W		Total	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
CHEM 309	259	30.9	201	24.0	82	9.8	37	4.4	53	6.3	206	24.6	**839**	**100**
CHEM 305	544	17.6	732	23.7	449	14.5	176	5.7	227	7.3	960	31.1	**3090**	**100**
CHEM 305-306	80	35.9	62	27.8	16	7.2	*	*	*	*	49	22.0	**223**	**100**
Total	**883**	**21.3**	**995**	**24.0**	**547**	**13.2**	**223**	**5.4**	**286**	**6.9**	**1215**	**29.3**	**4152**	**100**

** Cell size ≤ 10*

Figure 4. BIOL 430 grade distribution by CHEM course taken
District-wide data, Fall 2012 – Fall 2017



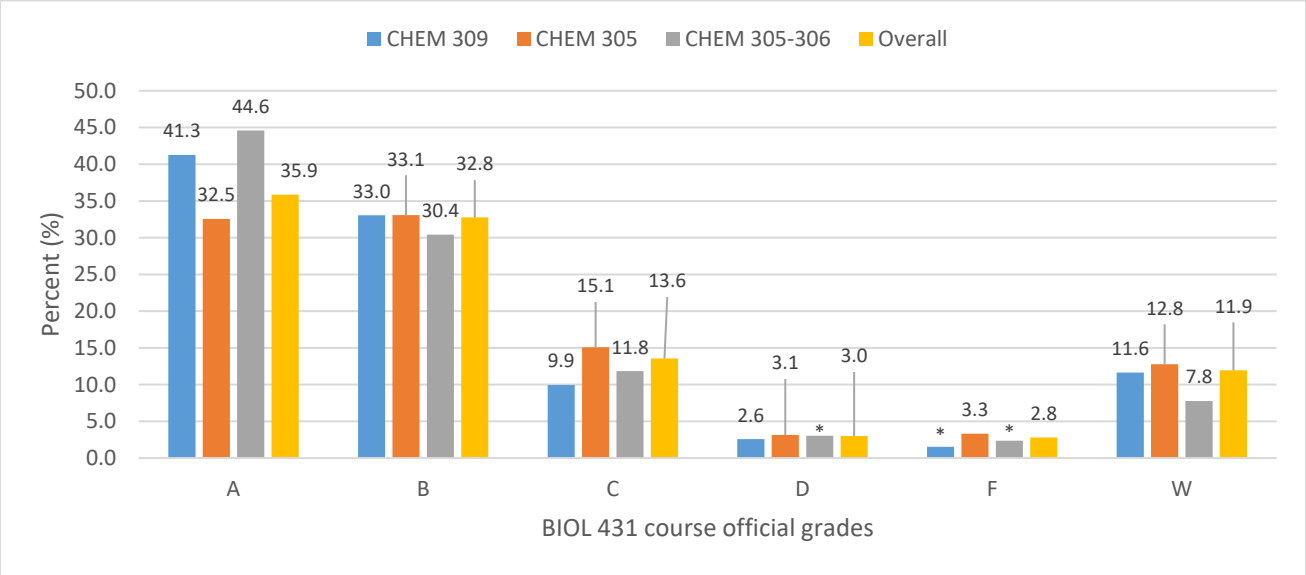
** Cell size ≤ 10*
Note small cell sizes for some grade categories, especially in CHEM 305-306. Table and Chart above do not show I, NP, and P grades due to small N.

Table 4. BIOL 431 grade distribution by CHEM course taken
District-wide data, Fall 2012 – Fall 2017

Type of CHEM Preparation	BIOL 431 course official grades													
	A		B		C		D		F		W		Total	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
CHEM 309	241	41.3	193	33.0	58	9.9	15	2.6	*	*	68	11.6	584	100
CHEM 305	561	32.5	570	33.1	260	15.1	54	3.1	57	3.3	220	12.8	1724	100
CHEM 305-306	132	44.6	90	30.4	35	11.8	*	*	*	*	23	7.8	296	100
Total	934	35.9	853	32.8	353	13.6	78	3.0	73	2.8	311	11.9	2604	100

** Cell size ≤ 10*

Figure 5. BIOL 431 grade distribution by CHEM course taken
District-wide data, Fall 2012 – Fall 2017



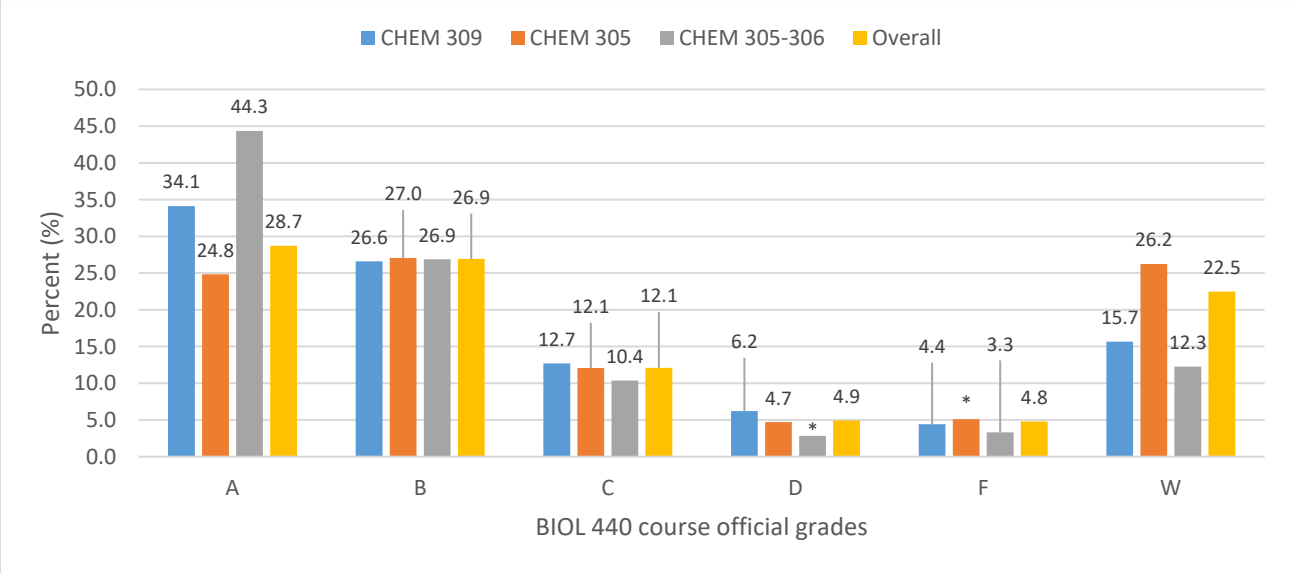
** Cell size ≤ 10*
Note small cell sizes for some grade categories, especially in CHEM 305-306. Table and Chart above do not show I grades due to small N.

Table 5. BIOL 440 grade distribution by CHEM course taken
District-wide data, Fall 2012 – Fall 2017

Type of CHEM Preparation	BIOL 440 course official grades													
	A		B		C		D		F		W		Total	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
CHEM 309	231	34.1	180	26.6	86	12.7	42	6.2	30	4.4	106	15.7	677	100
CHEM 305	449	24.8	489	27.0	218	12.1	85	4.7	92	5.1	474	26.2	1808	100
CHEM 305-306	94	44.3	57	26.9	22	10.4	*	*	*	*	26	12.3	212	100
Total	774	28.7	726	26.9	326	12.1	133	4.9	129	4.8	606	22.5	2697	100

** Cell size ≤ 10*

Figure 6. BIOL 431 grade distribution by CHEM course taken
District-wide data, Fall 2012 – Fall 2017



** Cell size ≤ 10*
Note small cell sizes for some grade categories, especially in CHEM 305-306.

BIOL COURSE SUCCESS BY GRADE RECEIVED IN CHEM COURSES

Next, we looked at BIOL course success rates by the grades students received in the CHEM course they had taken. Note that for the CHEM 305-306 group, we use the grades students received in the CHEM 306 course. There seems to be a positive linear relationship between CHEM course grades and BIOL course success. Students who received A grades in the CHEM courses have the highest success rates in all of the BIOL courses, followed by the B grades. In BIOL 430 and 440, the BIOL success rates of CHEM C grade students trail far behind those of A and B grade peers. However, the gap is much smaller in BIOL 431. This might have been because of the additional preparation these students received through successful completion of BIOL 430 before BIOL 431. Table 6 to Table 8 on the next page show success rates in BIOL courses by grades received in CHEM courses.

Table 6. BIOL 430 course success by CHEM grade
District-wide data, Fall 2012 – Fall 2017

Type of CHEM preparation	BIOL 430 course success							
	Biol 430 Success by A grades in CHEM		Biol 430 Success by B grades in CHEM		Biol 430 Success by C grades in CHEM		Overall	
	Count of Success	Course Success Rate	Count of Success	Course Success Rate	Count of Success	Course Success Rate	Count of Success	Course Success Rate
309	212	87.6	214	66.3	115	42.1	542	64.6
305	672	82.1	654	55.9	400	36.3	1726	55.9
305-306	65	87.8	64	73.6	29	46.8	158	70.9
Note: Table does not show P grades because of small N								

Table 7. BIOL 431 success rates by CHEM grade
District-wide data, Fall 2012 – Fall 2017

Type of CHEM preparation	BIOL 431 course success							
	Biol 431 Success by A grades in CHEM		Biol 431 Success by B grades in CHEM		Biol 431 Success by C grades in CHEM		Overall	
	Count of Success	Course Success Rate	Count of Success	Course Success Rate	Count of Success	Course Success Rate	Count of Success	Course Success Rate
309	194	95.6	188	79.7	109	75.7	492	84.2
305	529	89.5	510	79.3	352	71.8	1391	80.7
305-306	116	94.3	99	83.2	42	77.8	257	86.8
Note: Table does not show P grades because of small N								

Table 8. BIOL 440 success rates by CHEM grade
District-wide data, Fall 2012 – Fall 2017

Type of CHEM preparation	BIOL 440 course success							
	Biol 440 Success by A grades in CHEM		Biol 440 Success by B grades in CHEM		Biol 440 Success by C grades in CHEM		Overall	
	Count of Success	Course Success Rate	Count of Success	Course Success Rate	Count of Success	Course Success Rate	Count of Success	Course Success Rate
309	187	87.4	199	76.2	111	55.0	497	73.4
305	496	81.3	410	63.9	250	45.0	1156	63.9
305-306	84	93.3	66	79.5	23	59.0	173	81.6
Note: Table does not show P grades because there was no P grade in BIOL 440 courses.								

CLOSING REMARKS

The report examined the relationship between Biology course outcomes and type of Chemistry preparation in the Allied Health major using district-wide data from Fall 2012 to Fall 2017. There seems to be variations in each of the Biology courses' outcomes by the type of Chemistry preparation students had. Students who completed both CHEM 305 and CHEM 306 appear to have the highest success rates and highest proportion of grades A and B in BIOL courses, followed closely by those with CHEM 309. Students entering BIOL courses with only CHEM 305 have relatively lower course success rates than those with the other two types of CHEM preparation. Students entering BIOL courses with just CHEM 305 also have the highest proportion of W grades. Furthermore, there seems to be a positive linear relationship between the grades students earned in CHEM courses and BIOL course success. CHEM A grade and B grade students appear to be more likely to succeed in BIOL courses than their CHEM C grade peers.