What are the Benefits of Concurrently Enrolling in Lectures and Laboratories?

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Abstract

We provide evidence that enrolling in an introductory chemistry laboratory concurrently with the corresponding lecture course enhances learning gains and retention in comparison to students who enroll in the lecture alone. Specifically, concurrent enrollment positively impacts:

- the odds of retention in the lecture by 2.2 times on average, and
- final lecture grades by up to 0.19 grade points for the lowest-scoring students on the university's math and chemistry placement exams.

Rationale

Laboratories are uniquely suited for helping students achieve some specific learning goals (NRC, 2006), namely:

- understanding the complexity and ambiguity of empirical work, and
- developing practical skills.

However, little has been published on the relative *timing* of the lecture and lab (Matz, 2012), i.e., is it important to concurrently enroll?

National Research Council. (2006). America's Lab Report. Washington, D.C.: The National Academies Press.
Matz, R. L., Rothman, E. D., Krajcik, J. S., & Banaszak Holl, M. M. (2012). Concurrent Enrollment in Lecture and Laboratory Enhances Student Performance and Retention. Submitted to the *Journal of Research in Science Teaching*.

Additionally, a survey of 40 public universities with high undergraduate enrollment revealed that substantial percentage offer introductory biology (38%), chemistry (43%), and/or physics (33%) lectures and laboratories as separate courses without requiring concurrent enrollment.

University	Biology		Chemistry		Physics	
	C	NC	C	NC	C	NC
Indiana University		✓		✓	✓	
Michigan State University		✓		✓		✓
Ohio State University	✓		✓		✓	
Pennsylvania State University	✓			✓	✓	
Purdue University		✓	✓		✓	
University of Illinois		✓		✓	✓	
University of Iowa	✓		✓		✓	
University of Michigan		✓		✓		✓
University of Minnesota	✓		✓		✓	
University of Nebraska		✓	✓			✓
University of Wisconsin	✓		✓		✓	
Total (all 40 schools)	25	15	23	17	27	13

Data Set

- N = 9,438 students
- Enrolled in a fall chemistry lecture between 2002 and 2007
- Demographics (gender, ethnicity)
- Test scores (high school GPA, SAT, placement exams)
- Chemistry course information (final grade, withdrawal date)

Method

Multiple linear and binary logistic regressions were used to ascertain the effect of concurrent enrollment on final grades in and withdrawal rates from the lecture, respectively.

Predictors used in the regression analyses:

- High school GPA
- SAT score
- Enrollment status (concurrent or nonconcurrent)
- Cluster number based on math and chemistry placement exams
- Interaction of enrollment status and cluster number

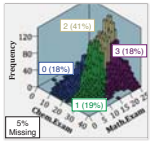
Results

Concurrent enrollment positively impacts the odds of retention in the lecture by 2.2 times on average (R^2 = 0.19).

Table 1

Predictor	*B*	*SE B*	*Exp(B)*	*p*
Constant	-5.41	0.98	0.00	0.00
(a) High school GPA	0.94	0.23	2.56	0.00
(b) SAT score	0.00[a]	0.00	1.00	0.00
(c) Enrollment status	0.79	0.21	**2.19**	0.00
(d) Cluster number	0.70	0.12	2.02	0.00
(e) Interaction of (c) and (d)	0.19	0.19	1.20	0.32

[a]It is positive for this predictor but rounds to 0.

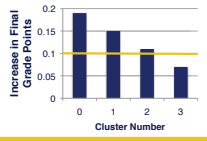


Concurrent enrollment positively impacts final lecture grades by up to 0.19 grade points for the lowest-scoring students on the university's math and chemistry placement exams (R^2 = 0.32).

Table 2

Predictor	*B*	*SE B*	*t*	*p*
Constant	-2.43	0.128	-19.0	0.00
(a) High school GPA	0.86	0.029	29.4	0.00
(b) SAT score	0.00[a]	0.000	18.4	0.00
(c) Enrollment status	**0.19**	0.027	6.9	0.00
(d) Cluster number	0.27	0.012	22.0	0.00
(d) Interaction of (c) and (d)	**-0.04**	0.015	-2.5	0.01

[a]It is positive for this predictor but rounds to 0.



Discussion

These data show that, in general chemistry, significant increases in performance and retention can be effected by relatively simple action. The results may be related to the structure of the laboratory course which exemplifies many principles that support effective science learning environments. In particular, **the heavy emphasis on collaborative work in combination with metacognitive processes and peer interaction may be the most important causal elements related to the outcomes described here.** Collaborative work has repeatedly been shown to enhance achievement, retention, and attitudes.

Conclusion

This quantitative study describes very practical outcomes that support the laboratory as a component in the best approach to teaching introductory chemistry, and provides important results for consideration by curriculum advisors and course planners at universities that do not require concurrent enrollment.

Limitations

We intended to analyze each student's first experience in the lecture and laboratory; however, we encountered two limitations:

- students could have enrolled prior to Fall 2002, and
- lecture data were collected only for fall terms; students could have enrolled for the first time during a winter or spring term.

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