JOURNAL OF CHEMICAL EDUCATION

Article

pubs.acs.org/jchemeduc

Poster Presentations: Turning a Lab of the Week into a Culminating Experience

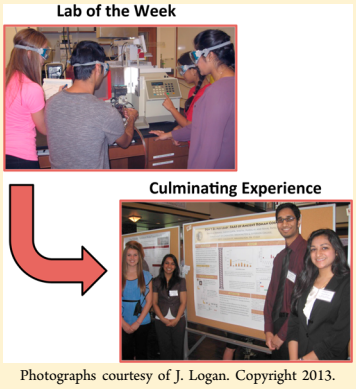
Jennifer L. Logan,*[,†] Rosalynn Quiñones,[‡] and Deborah P. Sunderland[†]

[†]Department of Chemistry, Washington & Jefferson College, Washington, Pennsylvania 15301, United States

[‡]Department of Chemistry, Marshall University, Huntington, West Virginia 25755, United States

Supporting Information

ABSTRACT: An assignment incorporating posters into a second-year analytical chemistry lab is described. Students work in groups and are assigned one of the application-themed weekly laboratories as a topic. Course data acquired for these weekly laboratories are compiled into spreadsheets that the poster group then analyzes to present in an on-campus poster session. Visual design with the use of minimal text is emphasized, and statistical analysis and spreadsheet usage are incorporated. This assignment provides the majority of students in the course with their first poster experience. By making the students revisit a previous lab and reconsider the topic using course-wide data, a simple lab of the week becomes an in-depth project culminating in a poster presentation. Student satisfaction with this assignment has been high both in terms of group work experience and the resulting poster.



Photographs courtesy of J. Logan. Copyright 2013.

KEYWORDS: *General Public, Second-Year Undergraduate, Curriculum, Analytical Chemistry, Communication/Writing, Applications of Chemistry, Student-Centered Learning*

A vital aspect of a chemistry curriculum is communication, with posters being a common method by which science students can disseminate their findings.[1] Learning how to design and present posters either to a general audience or at a scientific conference is a necessary skill. As a result, poster assignments often appear in chemistry courses.[2] Such posters might reflect topics of interest,[3−5] independent research,[6] lab projects,[7,8] or an exam.[9] One approach involves students designing weekly posters on each experiment in lieu of a weekly lab report.[10]

Given that communication is a critical skill, a poster assignment has been implemented in the analytical chemistry lab, a second-year course at Washington & Jefferson College. While posters in a lab course are not a new idea, our assignment has several aspects that, together, make it unique. First, students work in groups, developing teamwork abilities, a learning objective identified by the National Research Council as one of seven goals in a laboratory experience.[11] A second feature is that by integrating the assignment into a second-year chemistry course, the poster is a first for many. Younger students enrolled primarily in foundational courses thus gain earlier practice with poster design and presentation.

A third and particularly unique aspect of the assignment is that students analyze course-wide data collected for one of the weekly laboratories. They revisit a previous lab with which they are already familiar, learning more about the topic and using a large body of data to draw statistically sound scientific conclusions. In this manner, a lab of the week becomes a culminating experience for the course.

The poster assignment was first given in 2009 and has been tweaked each subsequent year. This work describes the assignment in its most recent form, offered in spring 2013 and reflecting an evolution over 5 years.

SETTING

The Analytical Chemistry Lab is a corequisite of the lecture and a requirement for chemistry, cell/molecular biology, and biochemistry majors as well as most prehealth students. This 4-credit course is offered every spring during a 13-week semester. Most are second-year students, in their fourth semester of chemistry. In the past 5 years, the course has varied from 34 to 58 students split among 3−4 sections with a maximum of 15 in each. Assignments for this course include 9 lab reports, an experimental figure exercise, a lab final, and the poster.

The course focuses on using spreadsheets to collect and analyze large amounts of data. Students learn to use built-in calculation functions and statistical analysis tools. They are taught to format data tables and calculations in a professional manner since visual presentation is an important aspect of communicating ideas. These spreadsheets also play a role in the poster assignment in which course-wide data are analyzed for trends.

OVERVIEW OF POSTER ASSIGNMENT

The primary motivation behind the poster assignment is to give younger second-year students their first scientific

dx.doi.org/10.1021/ed400695x | J. Chem. Educ. XXXX, XXX, XXX−XXX

Table 1. Schedule of Analytical Chemistry Lab Experiments Showing Appropriate Poster Topics and Related Assignments

Week	Lab Experiment	Poster Assignment	Poster-Related Assignment[a]
1	Glassware calibration		
2	Topic 1: Acidity of beer		Assignment on designing an experimental figure Topic 1 postlab involves analysis of course data using a spreadsheet
3	Topic 2: The hotness of hot sauce		
4	Topic 3: Detecting cocaine on currency		Topic 3 postlab includes a figure design/formatting assignment
5	Topic 4: Lead content of ancient Roman coins, Part I	Poster assignment is explained; students told to form groups, pick topics	
6	Topic 4: Lead content of ancient Roman coins, Part II	List of group members and top 3 poster topics due	
	Topic 5: Partition coefficient of pharmaceutical drugs		
7	No lab	Students are emailed group assignments and poster topic[b]	
8	Spring break		
9	Topic 6: Metals in water		
	Topic 7: Water hardness, Part I		
10	Topic 7: Water hardness, Part II		
11	Accuracy test	Topics 1, 2, and 3 posters due	
12	No lab	Topics 4, 5 posters due	
13	Excel exam, lab cleanup, and check-out	Topic 6 poster due	
14	No lab	Topic 7 poster due	
Last day of regular classes		Poster Session	

[a]These assignments are designed to help students develop skills necessary for making their poster. [b]Topic assignment occurs after all but 2 of the 7 topics have been completed in the lab. Disruption due to instrument breakdown is thus minimized with respect to posters.

presentation experience. Many move on to summer research programs or independent studies where they might present at a conference or symposium. Using the on-campus poster session provides a familiar, less intimidating environment for students to gain their first experience, preparing them for future endeavors.

Students work in groups of 3−4 to design and present a poster on data collected earlier in the semester. This approach is similar to that adopted by Renaud et al. in which weekly physical chemistry experiments became topics for posters.[8] In our assignment, however, students analyze data collected across all sections of the course, thus expanding the possibilities for statistical analysis. These laboratories are all application-based (Table 1), providing interesting topics related to everyday life and testing a variety of real-world samples. Using commercial samples or those collected from an environmental site provides students a sense of ownership that better engages them than if they were analyzing a predispensed unknown material.[12,13]

For this assignment, students generate a 54 in. × 40 in. (4.5 ft × 3.33 ft) poster. The poster contains the standard sections (introduction, experimental section, results and discussion, conclusion) with title, authors, affiliation, acknowledgments, and references included. The finished product is submitted as a pdf via email along with an 8.5 in. × 11 in. colored print-up and abstract.

SPREADSHEET DATA COLLECTION

Data for a given lab are collected in a Microsoft Excel spreadsheet. One lab, for example, assesses whether trace amounts of cocaine appear on currency using gas chromatography−mass spectrometry (GC-MS).[14] Here, students input information into a preformatted spreadsheet about their currency and the chromatography peak corresponding to cocaine (Figure 1). The group responsible for presenting a poster on this topic analyzes the compiled data, looking for trends in the amount of cocaine per bill based on year, condition, and so on. Students typically input their measurements into a master spreadsheet before leaving the lab. Part of the course grade (50 out of 1,300 points) is for successful data entry.

While spreadsheet compilation was done primarily for the poster assignment, such data collection has additional pedagogical benefits. Significant figures were emphasized where a 10 mL volumetric pipet would need to be reported as a measurement of 10.00, not 10. By making students use the increase/decrease decimal tool, the significance of zeroes to the right of the decimal place can be emphasized in the context of reporting data that the students themselves measured. More complex analysis is also possible with compiled spreadsheet data. For example, a lab where students used titration to determine the acidity levels of various beers could be used to assess the impact of decarbonation. One lab section titrated freshly opened beers while another analyzed decarbonated beer. Students could thus use compiled data to determine whether or not decarbonation leads to a significant difference in acidity. Statistical analysis involving paired *t* testing can also be done for experiments where students must consider more than just their one data point.

VISUAL EMPHASIS

Word Limit

The "visual message" of a poster is critical in engaging an audience and disseminating information.[15] To this end, visuals are emphasized in the assignment. When first done in 2009, students created posters resembling lab reports copied and pasted onto giant sheets of paper (Figure 2A). Further constraints were thus imposed with a limit of ∼200 words (not including captions, references, acknowledgments, titles, or labels on figures). The result has been more visually interesting posters

dx.doi.org/10.1021/ed400695x | J. Chem. Educ. XXXX, XXX, XXX−XXX

	A	B	C	D	E	F	G	H	I
1		Currency Description				Technique 1		Technique 2	
2						Half Bill	Cocaine	Half Bill	Cocaine
3	Name	Currency	Amount	Year	Condition	Mass (g)	Peak Area	Mass (g)	Peak Area
4	Michael B.	U.S. Dollar	$1	2003	7	0.5051	243495	0.4856	186127
5	Joseph G.	U.S. Dollar	$1	2009	7	0.5005	15869	0.4899	14811
6	Josiah R.	U.S. Dollar	$1	2006	6	0.5040	25654	0.5087	19324
7	Colten C.	U.S. Dollar	$1	2009	3	0.5057	810	0.4927	70
8	Katharine D.	U.S. Dollar	$1	2009	6	0.4911	2578	0.4825	8536
9	Tyler D.	U.S. Dollar	$1	2006	7	0.4940	13771	0.4944	12830
10	Kyle S.	U.S. Dollar	$1	2006	7	0.4903	1428	0.5142	12400
11	Clairesa J.	U.S. Dollar	$1	2006	6	0.5155	32629	0.4964	28416
12	Ashley G.	U.S. Dollar	$1	2003	9	0.4526	1233	0.4643	152
13	Lucas C.	U.S. Dollar	$1	1995	7	0.4790	24920	0.4813	4667
14	Marshall F.	U.S. Dollar	$1	2009	4	0.4823	1959	0.4902	13017
15	Nicholas T.	U.S. Dollar	$1	2003	7	0.4938	1277	0.5006	58
16	Nihal P.	U.S Dollar	$1	2006	5	0.5235	29536	0.4942	14296

Figure 1. Example of a spreadsheet used to collect course-wide data for an experiment involving GC-MS analysis. Reproduced with permission from J. Logan. Copyright 2013.

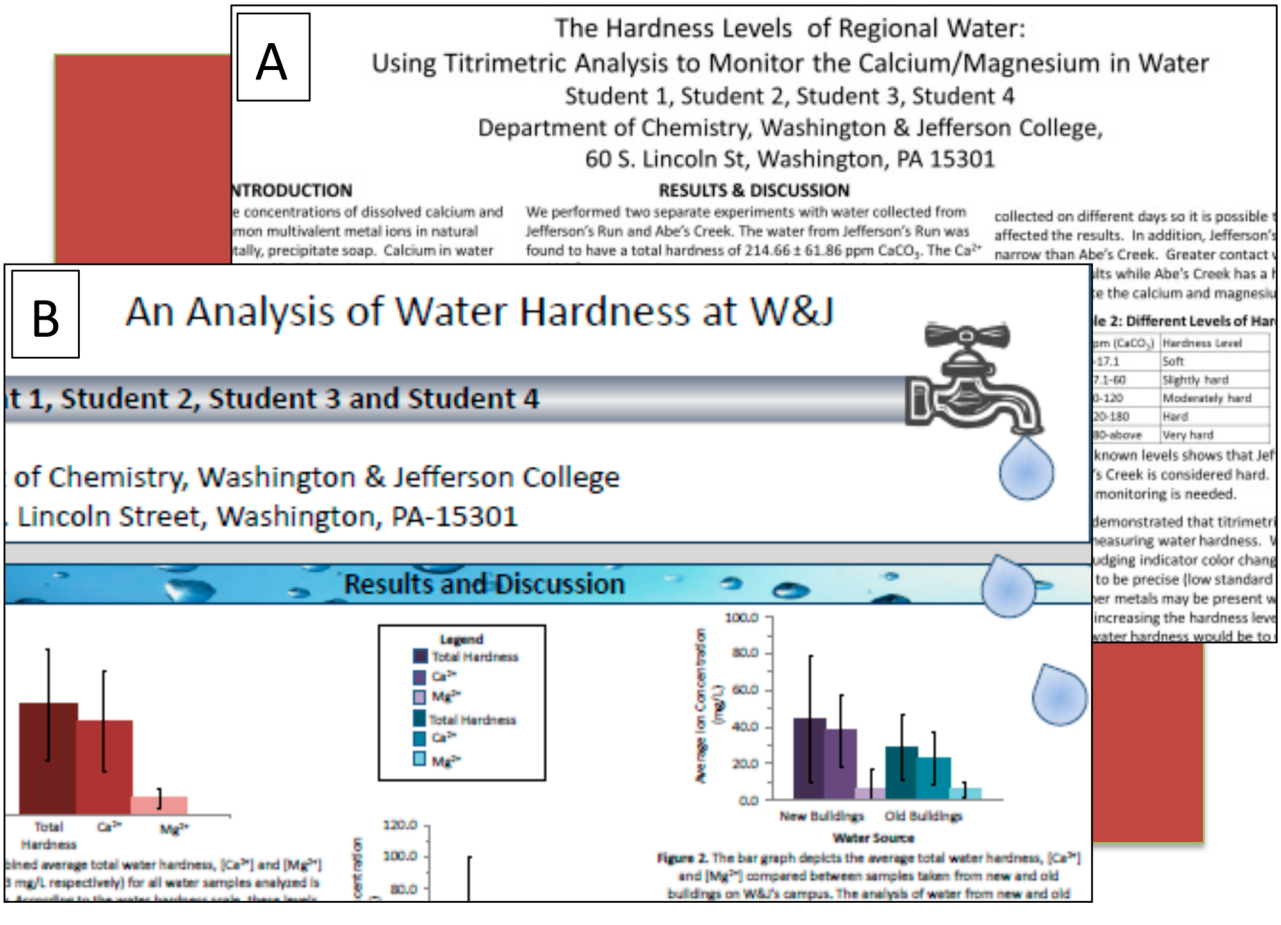


Figure 2. Excerpts from posters on the same topic reflecting (A) a heavy reliance on text and (B) a more eye-catching presentation. (Original posters are provided in the Supporting Information. Part A is reprinted with permission from J. Logan. Copyright 2009. Part B is reprinted with permission from C. Dee, K. Phillips, A. Rabon, and V. Smith. Copyright 2013.)

dx.doi.org/10.1021/ed400695x | J. Chem. Educ. XXXX, XXX, XXX−XXX

(Figure 2B). Given that the posters are presented in a venue supporting all liberal arts disciplines and an audience of undergraduates, parents, and general faculty, visual appeal is important in attracting interest. The idea of writing concisely is thus emphasized throughout the semester. Every lab report has a strict word limit, making students focus on key points and findings.

Figure Design

To further encourage visual thinking, a preposter assignment is given in which students create an experimental figure illustrating the procedure of a lab they did in a previous course (Table 1, Supporting Information). Several examples, from both student work and the primary literature, are discussed to assist them in describing a procedure with images, not words. Students can create figures using photographs, original electronic drawings, or images from the Internet. An example of the work that one student produced is provided in Figure 3. It should be noted that

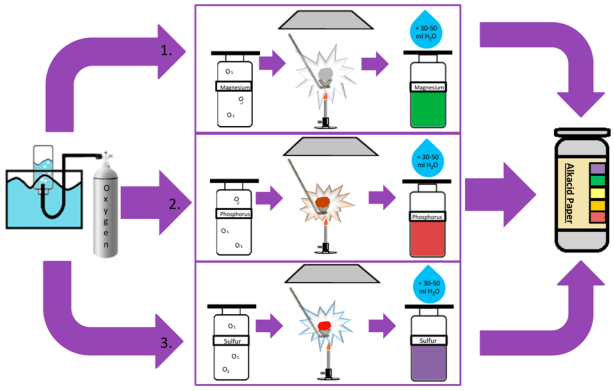


Figure 3. Example of a figure designed by a student to illustrate a lab on metal oxide reactivity from a previous chemistry course. This assignment forces students to explain a procedure visually, practicing this skill prior to creating their poster. Reproduced with permission from A. Rabon. Copyright 2013.

the quality of these figures varies depending on familiarity with design software. Grading, however, focuses on the ability to convey a procedure's main points. Whether done so through the simple assembly of Internet images or through original drawings is beside the point, at least for the level of this assignment. A similar approach is taken for the poster. Students are told they can generate figures however they wish, giving them greater flexibility in determining what works best in designing a more visual story.

Part of creating a poster requires figures that are professional in terms of formatting and appearance. To guide students in such design, an assignment was included in a postlab in which students used their own data to mimic a figure provided by the instructor (Table 1). Using their GC-MS data, students had to generate a figure adhering to ACS guidelines that mimicked the instructor's shown in Figure 4. Students thus practiced generating a figure different from the one Excel might have generated based on a default style.

LOGISTICS

Poster Software

Posters can be developed using several software platforms. Adobe InDesign training for creating posters was given in 2009

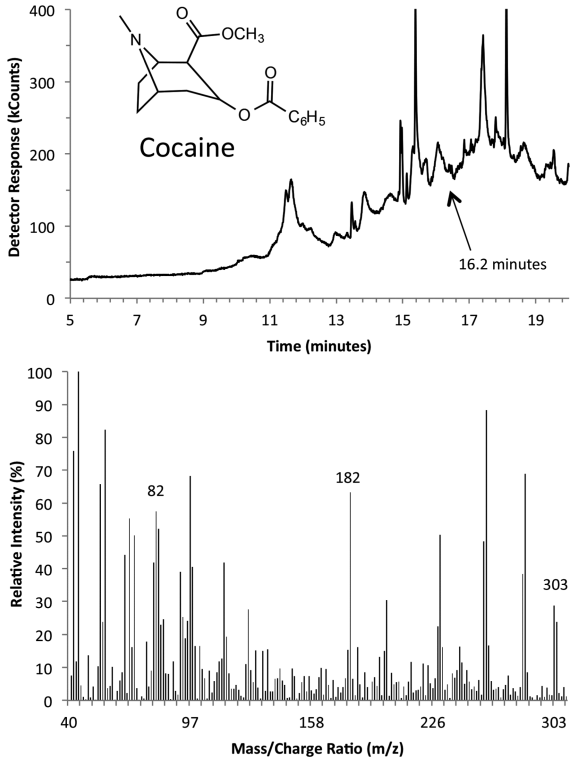


Figure 4. Developing a publishable figure. Students use their own data to generate graphs mimicking the ones provided here. This exercise familiarizes students with formatting and the idea of creating clean, crisp images with informative labels. Reproduced with permission from J. Logan. Copyright 2013.

and 2010. Since then, however, students have been encouraged to use the more familiar Microsoft PowerPoint or Publisher. Outside of a brief overview, software training has not been included in the past 3 years. Instead, students are referred to online guides provided by the college and are encouraged to seek the instructor for any questions. Cutting training has saved time with minimal issues. By working in groups of 3−4, chances are high that at least one student is familiar with the appropriate software.

Group and Topic Assignments

Students form their own groups of 3−4 people and submit their top 3 choices for poster topics. Doing so reduces possible complaints about unequal work distribution and helps maximize group functionality by allowing students to pick their team mates, be it lab partners or students from other lab sections. They then email the instructors with the names of their group members and their top 3 poster topics by a certain date (Table 1). Making the poster assignment a group one makes it less onerous for the student and more manageable for the instructors with respect to logistics and printing. Admittedly, additional issues can arise with group work and dynamics, but the workload remains doable.

The instructors then announce (via email) the finalized groups and their topics. While most groups represent the ones formed by the students, a few typically need the instructor's help in finding a third or fourth member. Instructors assign topics based on the following parameters: (1) each group will have one of their top 3 choices, (2) all topics will be covered, and (3) no more than 2 groups will be assigned the same one. Distributing the topics in this manner gives students a sense of ownership over a

dx.doi.org/10.1021/ed400695x | J. Chem. Educ. XXXX, XXX, XXX−XXX

particular experiment since they might be the only ones assigned to it. For the 5 years that this assignment has been done, each group has always been assigned one of their top 3 choices.

Due Dates

Posters are due at various times during the semester, depending on the topic (Table 1). These staggered deadlines are to ensure fairness in terms of giving students equal time (generally 3 weeks) to analyze their data and create a poster. An additional benefit is that it allows the instructors time to work more with each group. One challenge is, admittedly, giving adequate time to students creating posters on later topics. For these groups, the instructors are especially quick in grading the lab reports so that students have feedback on their calculations. To alleviate this issue, more groups are assigned an earlier topic with only a few having later ones.

POSTER PRESENTATION

The resulting posters are presented in a campus-wide session held at the end of the semester. Poster sessions in the sciences have been done at Washington & Jefferson College since the early 1990s. In spring 2013, 138 posters were presented by 232 students, representing 20 different courses (from disciplines as varied as biology, music, and sociology) as well as independent research. The poster session is typically split into two sessions (1.5 h each) with an audience composed of undergraduate students, faculty, family, and administrators.

In the past 5 years, 9−15 posters/year have been presented for the analytical chemistry course. Students dress professionally and give 8−10 min presentations to the instructors with equal participation among the group (Figure 5). They also respond to follow-up questions posed by the instructors or other audience members.

Figure 5. Students present their poster during a campus-wide poster session; they are assessed on their ability to summarize their work and respond to follow-up questions. Photograph courtesy of R. Reid. Copyright 2013.

ASSESSMENT

The poster assignment is worth 150 points (out of a total of 1,300 points) of the lab grade, making the poster 1.5× the number of points of a lab report. Grading concentrates on layout, visual appeal, and inclusion of all necessary sections and elements. In addition, students are graded on their presentation during the poster session as well as their submitted abstract. Students are *not* graded on the correctness of their data. Instead, this is done in a second related assignment, known as the data analysis report.

This secondary assignment was created in 2011 in recognition of the significant amount of work that goes into generating the numbers and figures seen in a poster. Here, the student groups submit the calculations they did for their poster. Despite the variety of poster topics, this assignment (described in more detail in Supporting Information) is uniform in that the student groups are assessed on their ability to report significant figures, propagate uncertainty, conduct appropriate statistical testing, properly format figures, and do correct calculations. The data analysis report (worth 8% of the lecture grade) replaced previous homework assignments that had tested on similar concepts. Grading of this report thus focuses on the data content that went into the poster itself while holding students accountable for typical skills developed in studying analytical chemistry. Rubrics for both the poster and data analysis report are provided in the Supporting Information.

PEER ASSESSMENT

The group work aspect of the poster assignment encourages collaboration and conflict. Being able to select their own groups generally leads to fewer complaints about noncontributing partners. In addition, students rate the contributions of their peers by distributing a total of 3 points × the number of group members among their partners. For example, a group of 4 would have 12 total points to allocate and scores of 3 would reflect equal participation by all. Students email the instructor (in confidence) their ratings and explanations a week after completing the poster assignment. These ratings become a part of the final poster grade.

Implementing the group rating system has reduced issues involved with team work. It is unfortunate that group projects, either in the classroom or in a job, are often "not fair" in terms of work distribution. Whether such inequity is real or perceived, it is difficult to enforce that all students contribute equally to the assignment. Allowing students to rate their peers provides a means by which such disparity can be addressed, at least to a degree. It also encourages those who might contribute less to participate more in their group's efforts. A refreshing outcome is that many were honest and generous in their assessment, sometimes scoring themselves lower than their peers. A few, inevitably, did not provide ratings even after several reminders. Total scores were adjusted accordingly, and the students who did not respond lost additional points.

STUDENT OUTCOMES

A goal of this assignment is to provide younger students with their first experience in poster design and presentation. In the past 5 years, an average of 83% of the students did their first poster during the semester that they were enrolled in Analytical Chemistry. Granted, some students were concurrently taking other courses that also involved posters. These students would have experienced poster presentation regardless of whether or not they were in this course. For a significant portion (65%), however, this assignment represented the first and only poster they made prior to subsequent semesters. Colleagues have reported that additional benefits have been that their (1) upper-level research students now know how to design and make posters and (2) the quality of these research posters has improved.

For the 2013 offering, 39 students completed an anonymous survey following completion of the poster assignment. On a scale of 1 (dissatisfied) to 5 (satisfied), students responded that they were pleased with their poster (4.2 ± 0.8). With respect to working in groups, they also rated their experience with high satisfaction (4.4 ± 0.5). These results are promising in terms of

dx.doi.org/10.1021/ed400695x | J. Chem. Educ. XXXX, XXX, XXX−XXX

student happiness with the entire assignment. A few reflected this contentment with comments such as "I think [my poster] looks beautiful," "I like the finished product," "[the poster] looks wonderful," and "I think it turned out really well."

Students also provided feedback on what they thought the biggest challenges were with respect to the assignment. About 39% reported issues with poster design and content. They recognized the challenges of deciding what material was most relevant, fitting it into limited space, and making the overall product aesthetically pleasing. Such frustration demonstrates that many students were especially conscientious about creating an intriguing, informative poster. Other concerns included difficulty with finding common times for group meetings (15%), software issues (13%), and group dynamics (10%). In the future, the instructors hope to use some lab time for working on posters to help address these issues.

■ ADDITIONAL OUTCOMES

An advantage of this assignment is that donated posters can be displayed to better showcase the chemistry program. The department thus benefits from the students' creativity and their eye-catching work. Students, in turn, are proud that their poster is displayed for all to see. The poster assignment can also be extended to involve peer assessment where students judge and critique other posters.[10]

■ CONCLUSION

An assignment in which second-year chemistry students present a poster is described. Implemented into an analytical chemistry lab over the past 5 years, various challenges have been encountered and addressed. Text heavy posters were eliminated through word limits and earlier assignments involving figure design. Problems regarding team work were mitigated through the implementation of a group rating system. Visually appealing posters by previous students now provide helpful examples for current ones. Such developments have led to the students achieving at the level expected.

The poster assignment provides students the opportunity to revisit an earlier lab and examine data collected by the entire course. While such is not traditional research, the experience is an appropriate prelude to independent study. It gives students a chance to consider a large body of data with statistical analysis, pulling out a story to tell, determining what the most important aspects are, and weaving them into a visually compelling and informative display. A typical lab of the week experiment is thus transformed into a larger project, providing the culminating experience of a poster presentation to second-year students.

■ ASSOCIATED CONTENT

Supporting Information

Syllabus, more lab experiment information, poster assignment, grading rubrics, figure design assignment, and example posters. This material is available via the Internet at http://pubs.acs.org.

■ AUTHOR INFORMATION

Corresponding Author

*E-mail: jlogan@washjeff.edu.

Notes

The authors declare no competing financial interest.

■ ACKNOWLEDGMENTS

Rosalynn Quiñones was supported by RUI NSF Grant Award CHE-0956755. Additional support for curriculum development was provided by HHMI Undergraduate Science Education Grant No. 52006323. We thank the analytical chemistry students for their participation; Christine Dee, Kimberly Phillips, Allison Rabon, and Victoria Smith for contributing Figure 2B; and Allison Rabon and Robert Reid for providing Figures 3 and 5, respectively.

■ REFERENCES

(1) ACS Committee on Professional Training. *ACS Guidelines and Evaluation Procedures for Bachelor's Degree Programs*; American Chemical Society: Washington, DC, USA, 2008; pp 1−30.
(2) Raines, B. J.; Gomez, C. G.; Williams, K. R. Posters—Old tool, new tech. *J. Chem. Educ.* **2005**, *82*, 1118−1119.
(3) Dunstan, M.; Bassinger, P. An innovative model: Undergraduate poster sessions by health profession majors as a method for communicating chemistry in context. *J. Chem. Educ.* **1997**, *74*, 1067−1069.
(4) Sisak, M. E. Poster sessions as a learning technique. *J. Chem. Educ.* **1997**, *74*, 1065−1067.
(5) Huddle, P. A. A poster session in organic chemistry that markedly enhanced student learning. *J. Chem. Educ.* **2000**, *77*, 1154−1157.
(6) Dillner, D. K.; Ferrante, R. F.; Fitzgerald, J. P.; Schroeder, M. J. Integrated Laboratories: Laying the Foundation for Undergraduate Research Experiences. *J. Chem. Educ.* **2011**, *88*, 1623−1629.
(7) Kennedy, J. H. Poster Presentations for Evaluating Laboratory Coursework. *J. Chem. Educ.* **1985**, *62*, 1104−1104.
(8) Renaud, J.; Squier, C.; Larsen, S. C. Integration of a communicating science module into an advanced chemistry laboratory course. *J. Chem. Educ.* **2006**, *83*, 1029−1031.
(9) Mills, P. A.; Sweeney, W. V.; DeMeo, S.; Marino, R.; Clarkson, S. Using poster sessions as an alternative to written examinations—The poster exam. *J. Chem. Educ.* **2000**, *77*, 1158−1161.
(10) Wimpfheimer, T. Peer-evaluated poster sessions: An alternative method to grading general chemistry laboratory work. *J. Chem. Educ.* **2004**, *81*, 1775−1776.
(11) National Research Council. *America's Lab Report: Investigations in High School Science*; National Academy Press: Washington, DC, USA, 2005.
(12) Settle, F. A. Education for Analytical Chemistry in the United States from the 1950s to the Present. *Active Learning: Models from the Analytical Sciences*; ACS Symposium Series, Vol. *970*; American Chemical Society: Washington, DC, USA, 2007; pp 23−33
(13) Henderleiter, J.; Pringle, D. L. Effects of context-based laboratory experiments on attitudes of analytical chemistry students. *J. Chem. Educ.* **1999**, *76*, 100−106.
(14) Heimbuck, C. A.; Bower, N. W. Teaching experimental design using a GC-MS analysis of cocaine on money: A cross-disciplinary laboratory. *J. Chem. Educ.* **2002**, *79*, 1254−1256.
(15) Furlan, P. Y.; Kitson, H.; Andes, C. Chemistry, poetry, and artistic illustration: An interdisciplinary approach to teaching and promoting chemistry. *J. Chem. Educ.* **2007**, *84*, 1625−1630.