

ARTICLE

Analysis of Student Attitudes of a Neurobiology Themed Inquiry Based Research Experience in First Year Biology Labs

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Inquiry based research experiences are thought to increase learning gains in biology, STEM retention, and confidence in students of diverse backgrounds. Furthermore, such research experiences within the first year of college may foster increased student retention and interest in biology. However, providing first year students in biology labs with inquiry-based experiences is challenging given demands of large student enrollments, restricted lab space, and instructor time. Thus, we aimed to integrate a small neurobiology themed research experience within a three-week modular, first-year biology laboratory setting. For this, students first performed a whole class lab examining the effects of ethanol on movement and associative learning. Using skills they

acquired, the students devised, executed, and presented their self-designed experiments and results. Using pre- and post-course surveys, we analyzed student attitudes on their experiences, including technical skills, inquiry-based learning styles in which experimental outcomes are often unknown, and research in their first year of biology. Analyzing data collected for three years, we found that students self-reported gains in technical skills and positive attitudes toward inquiry-based learning. In contrast, we found that students did not self-report increased interest in research experiences in general.

Key words: CURE; inquiry-based learning; biology labs; first-year students; C. elegans; module courses

Introductory biology labs are integral for preparing and inspiring students in the sciences; they aid in providing inquiry skills, such as hypothesis development, experimental design, and data analysis, as well as technical skills needed to persist and thrive in the competitive workforce (Brewer and Smith, 2011). The Vision and Change report called for research experiences to be introduced early in students' education. Indeed, research experiences built into classes, including classroom undergraduate research experiences or CUREs, have been highly touted as a best practice to integrate students into the process of scientific inquiry and boost careers in science (Seymour et al., 2004; Lopatto, 2007; Russell et al., 2007). Data show that students report gains in self-confidence, independence of thought, and a sense of accomplishment (Lopatto, 2007). CUREs have also been shown to be more inclusive of women and underrepresented minorities within the sciences (Intemann, 2009; Espinosa, 2011; Hernandez et al., 2013; Bangera and Brownell, 2014). However, the best mechanisms to introduce research experiences into first-year science curricula are not clear.

There are many challenges to introducing research experiences in first year labs, including space, costs, large class sizes, and instructor time (Wang, 2017). Thus, many labs (including a subset at Juniata College) use "cookbook" or prescribed laboratory experiments that include clear lab results and allow for easier in-class student and instructor navigation. These labs still have merit, as students gain skills in hypothesis testing, data collection and analyses, and science communication. However, first year students come to college at various levels of academic preparedness, which can lead to uncertainty in skill level

and academic capability in any coursework (Taylor et al., 2014; DeAngelo and Franke, 2016). Additionally, the cookbook format of these lab courses, in which the hypotheses are created by others and the results are already known, may decrease student interest in the STEM fields as students are less intellectually invested (Hoskins et al., 2007). The introduction of inquiry-based courses, in which coursework resembles goals of an actual research lab, allows students to participate as partners in research and feel intellectually challenged and stimulated.

First-year students can gain many skills during inquiry-based labs that help them better engage with their remaining science courses. The benefits include learning to collaborate, design experiments, communicate findings, and set personal goals. However, an obstacle to student learning is the preparedness of first-year students. A survey of participants in an Emory University Summer Undergraduate Research Experience (SURE) program showed that larger gains were reported in science inquiry and communication from students that previously self-reported low ability in those areas at the start of the program (Junge et al., 2010). Students may also struggle with labs that have unknown results and unpredictability. Many view the approach of the instructor, who guides rather than directs, as a lack of quality teaching or instruction instead of the intentional strategy to motivate students to work independently to develop their inquiry skills. Thus, a challenge for first-year inquiry-based labs is designing the course to efficiently balance instruction, so the students feel like they are receiving sufficient direction and knowledge, and independent work so the students can develop critical skills of inquiry and discovery.

To examine these issues, we introduced a research

Day	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6
General Topic	Introduction to the lab, overview of techniques	Using microscopes to collect data	Using microscopes to test a hypothesis I	Using microscopes to test a hypothesis II	Self-proposed research question completed	Poster presentation day
Learning outcomes	Learn parts of a microscope and Kohler illumination techniques; Practice using stereoscopes and compound microscopes and making observations of samples	Analyze cheek cells under a microscope; Perform a simple experiment analyzing the effects of mouthwash on cells; Use NIH ImageJ	Investigating animal behavioral responses to ethanol using physiological assays and performing microscopy technique	Introducing a second variable (mutants) to investigate neurobiological responses to ethanol	Independent scientific inquiry; group investigation	Presenting scientific research, analysis of data and poster presentation
Product	Notebook entry	Pictures of cells; notebook entry	Data collection and graphs; notebook entry	Data collection and graphs; Science inquiry worksheet; notebook entry	Data collection for the poster; notebook entry	Final Poster
Assessment tool	Lab entry	Lab entry, Quiz	Lab entry, Quiz	Quiz, Lab entry; Science proposal	Lab entry	Poster and Presentation

Table 1. Overview of the first-year lab module broken down into the key elements across the six days

experience into the first-year biology lab course at Juniata College, a small liberal arts school in rural Pennsylvania with approximately 1,600 students. We integrated a small self-driven, neuroscience themed research experience mixed with prescribed labs in our course. This course enrolls approximately 120 students per semester and is taken as a three-week module. Using pre- and post-course surveys, we asked students about their attitudes towards their knowledge, learning styles, and research experience. We found that most students reported gains in their technical knowledge and attitudes toward discovery-based learning styles. However, we did not find changes in their attitudes on the benefits of research experiences or future research goals.

MATERIALS AND METHODS

Participants

A total of 128 students were surveyed across three years (2016: 29 students; 2017: 71 students; 2018: 28 students) in a second-semester, first year biology class. Attitude surveys were approved by the Juniata College Institutional Review Board, and participants provided informed consent. Students voluntarily took the anonymous survey during the first and last day of their scheduled lab periods.

Survey

Students self-reported their attitudes toward this inquiry-based experience in pre- and post-course surveys, which were comprised of 10 questions each (see Table 2). Each question was answered on a Likert scale, from strongly agree to strongly disagree. Questions were broken down into three main categories: technical skills, learning styles, and research interest.

Statistical tests

All statistical analyses were performed using the R statistical package. The Likert scale was converted to a one-to-five scale. A Kruskal-Wallis test was performed on pre- and post- survey questions for the strongly agreed responses to find the Chi-squared value and P-value, as listed below in Table 2. A one-way ANOVA test was performed on all 10 questions and is reported in Figure 2, with additional analysis for the questions connected to attitudes on learning and research. The ANOVA was only done on post-survey responses from all three years surveyed. After the ANOVA were performed, a post-hoc TUKEY HSD test was run on each question to compare the changes between the three years, as also seen in Figure 2.

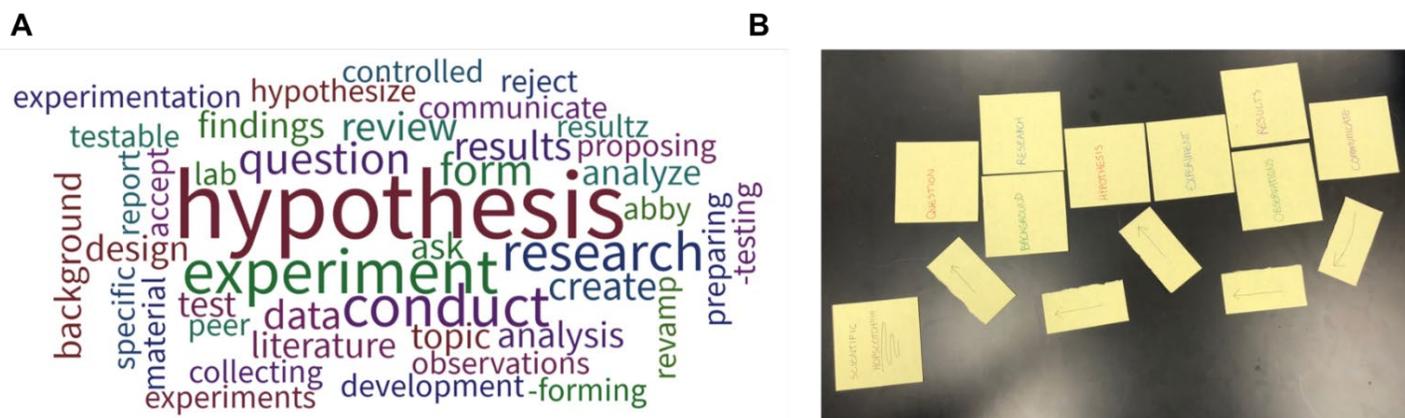


Figure 1. Examples of active learning activities to talk about scientific inquiry. (A) Responses, shown as a word cloud, to a brainstorm activity in which students identified important steps of scientific inquiry. Students could give multiple responses. (B) A general example of a concept map from the brainstorm made by students connecting the words of science inquiry. For this, students wrote the top words collected from the word cloud (hypothesis, experiments, research, etc.), wrote the words on stickies, and connected the words to best describe the process of scientific inquiry.

RESULTS

First-year biology students at Juniata College were enrolled in three-week rotations in laboratory classes that focused on different scientific techniques. We integrated a neuroscience themed research experience into one of the modules, which focused on microscopy techniques, mixed with “prescribed” experiments that allow students to learn techniques. The goals of the module were to 1) develop technical skills by using and applying microscopy techniques, 2) expose students to scientific inquiry and discovery-based approaches to learning, and 3) to communicate scientific content in the form of a poster presentation. For their research-based experience, students performed research using *Caenorhabditis elegans*, a model organism used to study many aspects of biology.

The laboratory module was carried out across six days (Table 1; Supplemental Material). Briefly, day 1 introduced students to scientific inquiry and the importance of microscopy in various disciplines, including biology. On day 2 students used the microscope to analyze cheek cells before and after a treatment with mouthwash (Listerine®, Johnson & Johnson, New Brunswick, NJ) and quantified changes in cheek cell size. The goal of the day was to allow students to practice using microscopes and complete a simple experiment. In days 3-4, students used the model organism, *C. elegans*, to examine the effects of ethanol on neuronal function, including movement and learning. They learned about controls and how to ask questions using model organisms. In days 5-6, they applied skills learned in days 1-4 to perform a self-generated research question, execute a research plan, and present their findings in the form of a scientific poster. Throughout the module, students worked in groups (usually 3-4 students), and kept the same group for the entire duration of the module.

Effect of alcohol-based mouthwash on cheek cell size

Students examined their own cheek cells before and after mouthwash treatment. This lab required students to learn how to stain cheek cells, prepare slides, and capture images using compound microscopes. Subsequently, images were quantitatively analyzed by measuring cheek cell circumferences using NIH ImageJ (Pemberton et al., 2018). The students observed and discussed the impacts of alcohol on cell size; they reported their data in tables, graphs, and representative images. This experiment served two goals: 1) it exposed students to basic microscopy skills, which facilitated their ability to develop and execute subsequent experiments examining the physiological responses in *C. elegans*, and 2) it served as an introduction to scientific inquiry, as students still develop hypotheses and collect data to test their hypotheses.

Alcohol effect on animal movement and learning

Dubbed the “Drunken Worms Project,” this two-day experiment allowed students to examine the effects of ethanol on neuronal function using a movement assay (thrashing behavior) and a learning assay (association to food stimuli) in *C. elegans*. Prior to this lab, students read a paper (Mitchell et al., 2007) that explored the effect of ethanol on worm movement. We also discussed the effects of alcohol on people, a very approachable topic for many first-year students. This served as a valuable resource to understand why cognitive and motor functions are changed when under the influence of alcohol. The second day of the Drunken Worms Project used the same techniques and experiments (iterative practice) to examine *C. elegans* mutants to determine possible contributors to ethanol signaling. Specifically, students tested the effects of ethanol on potassium channel mutants (*slo-1/BK* channel; Carre-Pierrat et al., 2006). This mutant is less

Questions asked	SA					Technical Skills					Kruskal-Wallis chi-squared value	P-value
	A	N	D	SD		A	N	D	SD			
Q1: How would you respond to the following statement: "I am confident in my ability to use a compound microscope."	Pre	10.9%	53.9%	24.2%	10.2%	0.8%						
	Post	62.7%	35.7%	1.6%	0.0%	0.0%					90.39	<2.2e-16
Q2: Do you believe that microscopy has a narrow application within the field of science?	Pre	1.6%	8.6%	15.6%	51.6%	22.7%						
	Post	2.4%	7.9%	8.7%	45.2%	35.7%					10.86	0.013
Q4: How would you respond to the following statement: "I understand the operational and application differences between a compound microscope and dissecting microscope."	Pre	2.3%	25.0%	27.3%	42.2%	3.1%						
	Post	46.4%	49.6%	1.6%	1.6%	0.8%					128.45	<2.2e-16
Q6: Would you say that you know how to use a slide and cover slip to visualize a specimen?	Pre	9.4%	46.9%	15.6%	22.7%	5.5%						
	Post	53.7%	42.3%	3.3%	0.0%	0.8%					81.95	<2.2e-16
Attitudes on Learning Style												
Q3: Do you believe that conducting data analysis is not an important step in a research project?	Pre	3.1%	3.9%	0.8%	26.6%	65.6%						
	Post	5.6%	2.4%	0.8%	26.4%	64.8%					4.72	0.19
Q5: How would you respond to the following statement: "I believe that I learn scientific concepts best through self-guided experimentation and trial and error."	Pre	20.3%	43.8%	27.3%	7.8%	0.8%						
	Post	30.2%	46.8%	19.0%	3.2%	0.8%					15.11	0.002
Q7: How would you respond to the following statement: "Communicating science, by making figures, including graphs, and presenting posters, improved my understanding of the material."	Pre	26.6%	52.3%	16.4%	4.7%	0.0%						
	Post	40.7%	48.0%	9.8%	1.6%	0.0%					16.37	0.001
Q10: How would you respond to the following statement: "I enjoy labs in which neither I, nor the professor, know the result(s) of the experiment."	Pre	25.2%	32.3%	29.1%	9.4%	3.9%						
	Post	31.2%	36.0%	23.2%	7.2%	2.4%					8.45	0.04
Attitudes on Research												
Q8: Do you think it is important for you to get experience conducting research at this stage of your of your college education?	Pre	58.6%	32.0%	8.6%	0.8%	0.0%						
	Post	58.1%	37.1%	4.0%	0.8%	0.0%					3.31	0.35
Q9: Are you likely to actively engage in a research project with a professor at Juniata or elsewhere?	Pre	43.8%	31.3%	21.9%	3.1%	0.0%						
	Post	43.5%	27.4%	26.6%	2.4%	0.0%					0.89	0.83

Table 2. The Pre- and Post- Survey questions were answered on day 1 and day 6 of the module, respectively. Each of the questions offered 5 possible answers on a Likert scale: Strongly Agree (SA), Agree (A), Neutral (N), Disagree (D), and Strongly Disagree (SD). The survey data was gathered over 3 years and strongly agree responses were analyzed through a Kruskal-Wallis test.

sensitive to the effects of ethanol and provided an opportunity to introduce how genetic mutations and model organisms can be used in scientific inquiry (Pokala and Glater, 2018).

For the movement assay, students examined how worms move in liquid using a thrashing assay (body bends assays, which are on solid agar media, have also been used with success). Briefly, worms move in an undulating pattern in solution, and the number of thrashes is indicative of their motor performance. Students washed worms onto depression slides and examined them under a compound microscope. Using cell phone mounts (Gosky cell phone adaptor mount), students used their own cell phones to take videos of worms thrashing in solution for 15 seconds and scored the number of thrashes in that period using the videos.

An animal learning assay was performed to examine the effects of ethanol on a learned response. The learned response conditioned worms to NaCl in the presence of a food stimulus and examined the animals' chemotaxis toward NaCl if given a choice later - an associative learning paradigm. Specifically, worms were grown on a plate with a bacterial food source and either NaCl or control (water). Later, when the worms were presented with a choice to move toward a spot of NaCl or a control spot, worms that were conditioned to NaCl and food move more toward the NaCl spot than the control spot. Thus, worms associated the NaCl with the food positive cue. Next, prior to conditioning, worms were treated with ethanol or control to determine whether ethanol pretreatment impaired the ability of worms to make this association. To quantify the choice, students calculated a chemotaxis index of all the groups (see Supplemental Material). As alcohol consumption is known to affect cognitive function, experiments like these provide a better understanding of the biology of alcohol and learning.

In their data entry component, students wrote a manuscript-style report, including introduction, methods, results, and discussion sections. The results of this entry combined the movement and learning assays; they contained representative images, graphs and tables of data, and text describing their findings. Thus, the students practiced many of the analytical components of science inquiry and scientific writing.

Student-designed experiment and poster

After learning microscopy and data collection skills, each group developed a hypothesis of their own and executed a research plan. To guide them through this process, students completed a science inquiry worksheet, which had them search through literature, state a hypothesis, and describe their experiment (see Supplemental Material). They were asked to include variables, controls, sample sizes, number of repetitions, and materials needed. Thus, this worksheet required them to plan and had the intention to expand the students' exposure and practice of scientific inquiry. As the lab module emphasized the process of scientific inquiry, this segment allowed students to be creative in their hypothesis and experiments and allowed

students to struggle with the complex steps involved in collecting their own data.

Subsequently, students prepared a poster for presentation. The poster included an introduction to relevant background information, a hypothesis statement, a methods and research design section, space for their results, and conclusions/future directions section (see Supplemental Material). While a poster template was provided, students were often very creative in their aesthetic display of the poster and its information. We projected posters onto our large projection screen and asked the students to present as a team while the audience filled out a presentation rubric. Both the poster and presentation rubrics were provided to the students ahead of time (see Supplemental Material).

Attitudes surveys

To better understand student attitudes towards inquiry-based labs, we developed a survey to ascertain student attitudes on their skills learning, learning styles, and research during college. Students were given a ten-question survey (Table 2), on the first day of lab prior to instruction (pre-class) and on the last day of lab after their presentations (post-class). Over the spring semesters of 2016, 2017, and 2018, 128 students voluntarily and anonymously participated in our study. The demographics showed that students were primarily first-year (97.2%) and were made up of 72% women to 28% men. The ten questions were broken up into three overall categories: 1) student attitudes toward their gaining of knowledge and skills, 2) student attitudes towards different learning styles and 3) student attitudes toward research and scientific inquiry. The data are summarized in Table 2.

We asked students to gauge their understanding of the technical aspects of the course in questions 1, 2, 4, and 6 (e.g., how to properly use a light microscope, slide preparation, etc.). We found large gains in self-reported skills; the largest increases were in student confidence in using a compound microscope (strongly agree responses increased on Q1 from 10.9% pre-class to 62.7% post-class), their understanding of compound and dissecting microscopes (Q4, from 2.3% to 46.4%), and their ability to prepare and visualize specimens using a microscope (Q6, from 9.4% to 53.7%).

A second set of questions asked about students' attitudes towards inquiry-based teaching, in which students and instructors do not have established answers to the experiments. Interestingly, we found some gains in the attitudes towards learning scientific concepts through trial and error (strongly agree responses increased on Q5 from 20.3% pre-class to 30.2% post-class) and enjoyment of labs in which students and professors do not know the results of experiments (Q10, from 25.2% to 31.2%). Thus, these data suggest that students are amenable to inquiry-based teaching strategies in which there is often uncertainty.

Finally, a last set of questions asked students about their interest in research at the college level. We asked whether students (most in their first year) think it is

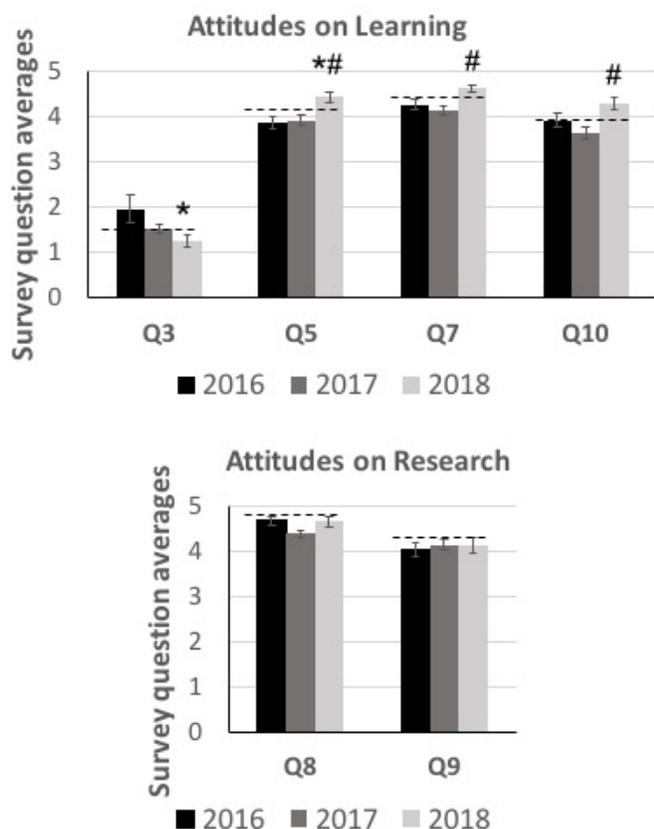


Figure 2. Comparison of post-survey scores by year for attitudes on learning (top) and research (bottom). Average scores indicated by the dashed black line. * indicates $p < 0.05$ compared to 2016, and # indicates $p < 0.05$ compared to 2017.

important for them to conduct research at this stage of their college education. We found that the strongly agree responses did not change from pre-class and post-class surveys (Q8, from 58.6% to 58.1%). In another question, we asked students if they were likely to engage in further research, and strongly agree responses again did not change (Q9, 43.8% to 43.5%). Thus, it appears that students' predetermined interest in research was not changed by the lab module.

We made minor changes to the module from year to year to incorporate the information we had gathered the previous year. For example, in 2018, a large emphasis was placed on introducing science inquiry as an important part of biology on day 1. This included activities such as brainstorming steps of science inquiry and developing a concept map of the scientific process. We used anonymous brainstorming responses (Poll Everywhere) in which students responded by submitting words or phrases to the question, "What are some steps of scientific inquiry?" This generates a word cloud (an example word cloud is shown in Figure 1A). Then, using words on the word cloud, students built a concept map using stickies (a general example of how words were connected is shown in Figure 1B). Each group explained their map to the rest of the class, and each group saw different models of how "steps" of science inquiry connect. Given our slightly increased emphasis on scientific inquiry, we examined

whether attitudes changed depending on year. Interestingly, we found that the average response for questions related to attitudes on learning styles showed significant increases from 2017 to 2018 (Figure 2 and Table 3). Specifically, students self-reported increases in their belief of learning through self-guided experimentation (Q5; $p < 0.05$), learning through making graphs (Q7; $p < 0.05$) and enjoyment of labs in which instructors and students do not know answers (Q10; $p < 0.05$). Thus, our modified lab that increased emphasis on scientific inquiry may have encouraged students more about the process of inquiry as important to their learning. Question nine ("are you likely to actively engage in a research project [in the future]") did not indicate significant change. This data supports the earlier claim that students' attitude on research was not changed by this lab; those who came in with no interest in research completed the course with no shift in attitude.

DISCUSSION

In the *Vision and Change* report (Brewer and Smith, 2011) released by the American Association for the Advancement of Science, several action items were suggested to help shape future science curricula. Several of these action items directly apply to inquiry-based learning strategies and are aimed to keep students engaged with science as they move through their undergraduate career. For example, *Vision and Change* called for the necessity to consistently relate abstract biological concepts to real-world examples and to make biology content relevant to the students by presenting problems in the context of real-life. Indeed, real world examples are shown to increase the use of scientifically accurate and detailed explanations in describing real world phenomena (Potter et al., 2017). Here, students conducted experiments examining the effects of alcohol on memory and movement (days 2-4 of our module), issues that are relatable to college life and real-world issues. Then, students investigated—short research questions based on their interests using the assays and techniques established the first days of the module. Furthermore, V&C suggested exposing students to science inquiry earlier, which has been predicted to foster retention and interests in the field. Our module is targeted to first year biology students, and early engagement with science inquiry has been linked to increased graduation rates in STEM (Rodenbusch et al., 2016). Thus, early exposure to research that increases connections to students' everyday lives may lead to increased learning gains and retention.

Our course was a three-week module that mixed "cookbook" labs with a true self-discovery research experience. Students self-reported gains in technical skills in microscopy and in their attitudes towards learning with open ended, inquiry-based activities where instructors may not know answers. Other undergraduate research experiences, such as CUREs and SUREs, have also reported student learning gains with their program (Lopatto, 2007; Junge et al., 2010; Nybo and May, 2015). Mader et al., 2017 compared learning gains of Course-based Research Experiences (CREs), modular CREs, and

	Post- Score Average			ANOVA		Fold Difference		
	2016	2017	2018	F	P	2016-2017	2017-2018	2018-2016
Q1	4.70	4.54	4.70	1.59	0.21	0.97	1.04	1.00
Q2	2.33	1.91	1.67	3.53	0.033*	0.82	0.87	0.71*
Q3	1.97	1.54	1.26	3.46	0.035*	0.78	0.82	0.64*
Q4	4.28	4.39	4.52	0.88	0.42	1.03	1.03	1.06
Q5	3.87	3.93	4.44	4.69	0.011*	1.02	1.13*	1.15*
Q6	4.68	4.44	4.37	1.87	0.16	0.95	0.98	0.93
Q7	4.28	4.13	4.63	5.07	0.008**	0.97	1.12*	1.08
Q8	4.69	4.40	4.67	3.32	0.040*	0.94	1.06	1.00
Q9	4.03	4.15	4.15	0.18	0.84	1.03	1.00	1.03
Q10	3.93	3.66	4.30	4.03	0.020*	0.93	1.17*	1.09

Table 3. One-way ANOVA and Tukey's Post Hoc. Ran on all 10 questions and used to compare the post-course survey scores across and between all three years. Fold differences were analyzed and the those with significant p-values (as indicated by the Post-hoc) were indicated with an asterisk. *p-value <0.05; **p-value <0.01

SURES in the categories of student understanding, skills and abilities, and personal development. Students in modular CREs showed the greatest gains in "Understanding of how scientists work on real problems," "Ability to Analyze," "Learning lab techniques," "Tolerance for Obstacles," and "Readiness for Research" (Mader et al., 2017). The lowest gains in benefits for modular experiences were "Skills in how to give an effective oral presentation," "Learning ethical conduct in your field," and "Clarification of a career path."

Our restriction of the modular course to three weeks may have limited the time available to develop important learning gains. SUREs and CUREs are much longer and provide students with more time to practice scientific inquiry. Indeed, a study on students with multi-year research experiences found that experienced students who spend three or four years in a lab publish papers, take greater responsibility for their projects, and show increased initiative and intellectual independence. Additionally, novice students report gains in cognitive skills, increased confidence in completing research-oriented tasks, and increased patience when confronted with setbacks (Thiry et al., 2012). Furthermore, year-long CURES have been shown to provide gains in conceptual knowledge in lower performing students (Peteroy-Kelly et al., 2017). A similar semester long upper level neuroscience course, which used a series of prescribed labs followed by an open ended project, found positive student responses, although data was not collected (Lemons, 2012; Pokala and Glater, 2018). Not surprisingly, these studies suggest that longer research experiences provide the most gains in student growth. Thus, implementing inquiry based labs in traditional once-a-week introductory labs at other colleges will still present challenges.

Our pre- and post-course surveys also found that students did not change in their attitudes on future participation in independent research and on the

importance of conducting research in their first year. However, pre-course survey responses suggested that approximately 90% of students either strongly agreed or agreed that it was important to gain research experience early in their college education. Interestingly, other studies of undergraduate research at Liberal Arts Schools like Juniata College showed that research reaffirms students' pre-existing career and educational goals (Seymour et al., 2004; Hunter et al., 2007). This finding differs from studies at non-Liberal Arts Colleges, where undergraduate research experiences introduce the idea of graduate school and increase the likelihood that students will choose to continue their scientific education and enter the scientific workforce (Kremer and Bringle, 1990; Bauer and Bennett, 2003; Lopatto, 2004; Russell et al., 2007). Indeed, an interdisciplinary CURE at Butler University that included Neurobiology showed that 75% of students proceeded to independent research and overall the CURE helped clarify career goals (Kowalski et al., 2016). Furthermore, for underrepresented minority students, the introduction of graduate school as an option for continuing education and development of a career goal are important outcomes (Villarejo et al., 2008; Boden, 2011). Our modular course structure did not expose students to career opportunities and professional mentorship within a field of study. Others have also noted that CUREs are not as effective in providing sufficient mentorship that one might find in a SURE (Auchincloss et al., 2014).

There are several areas in which our course can be improved to increase student interest and improve their learning gains. First, emphasizing specific messages such as the possibility of graduate school and medical school as feasible post-secondary options may be important. Second, framing the course to connect their work to real world situations can pique their interests in research and science career options (Harrison et al., 2011). Our course has already attempted to do that using alcohol's effect on

neuronal function. A future topic of study could be the opioid crisis which is affecting people across the country, but particularly local to our college's location. Finally, the survey was kept short to minimize the time it took to complete. However, new questions could be asked to better address more specific assessment questions including learning gains. Thus, increased analyses and adjustments of our content, teaching strategies, and emphasis on careers may lead to larger gains.

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Received May 6, 2018; revised July 19, 2018; accepted July 20, 2018.

Acknowledgements: We thank the Biology department at Juniata College for their work on this module and on first year science inquiry, including Drs. Chris J. Grant, Randy L. Bennett, and Beth Johnson. We also thank the Innovative Education Initiative at Juniata College for supporting our course redesign. Jeffrey L. Brabec and Margaret R. Vos are undergraduate coauthors of this manuscript.

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