

# CLASSROOM RESEARCH WORKING PAPER SERIES

*Volume 3*

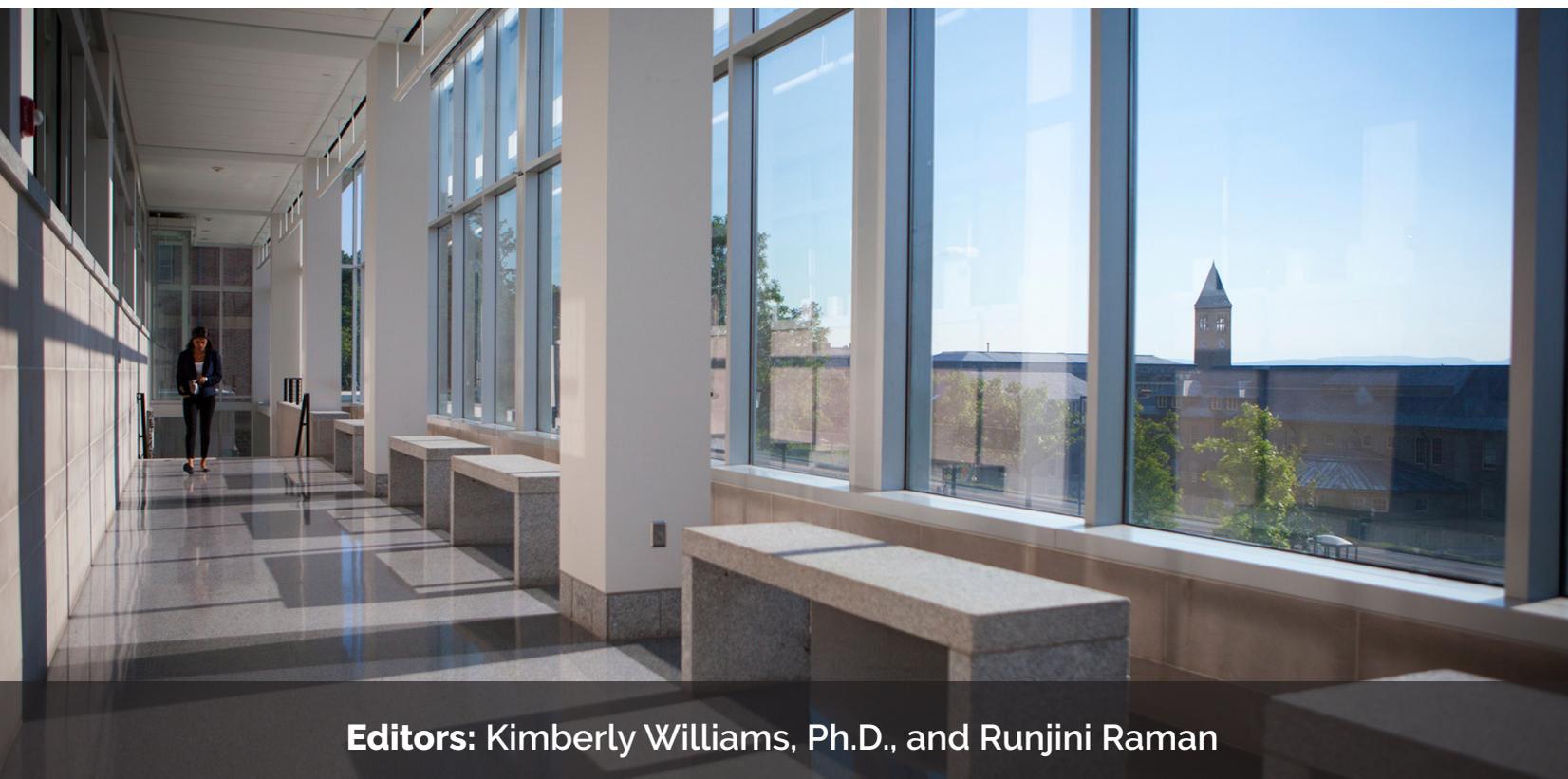
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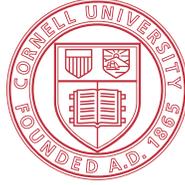
Center for the Integration of Research, Teaching, and Learning (CU-CIRTL)

Sponsored by the Council of Graduate Schools, Teagle Foundation, and National Science Foundation



**Editors:** Kimberly Williams, Ph.D., and Runjini Raman





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## **2013–2014 Graduate Research and Teaching/Teagle Fellow Contributors**

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Cornell University

**CENTER FOR TEACHING EXCELLENCE**

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Cornell University  
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## **PART I: LABORATORY, RESEARCH, PEDAGOGY AND CURRICULUM: TOWARD NEW FRONTIERS**

# Impact of Concurrent vs Non-Concurrent Enrollment in Genetics Lecture and Laboratory

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### **Abstract**

The laboratory section of a course is considered by course coordinators and department heads to be an integral part of the learning process in many scientific disciplines. The lab course frequently delves deeper into the material than the lecture and allows students to perform experiments that may have been involved in the discovery of major concepts within the subject. These courses are designed as companions to the lecture that support and reinforce the concepts and content. With the introduction of a non-concurrent enrollment option for the undergraduate Genetics laboratory and lecture courses at Cornell University, this study sought to determine whether or not registration concurrency impacted overall performance. Due to a small sample size at the time of this study, results are generally inconclusive but tend toward the suggestion that non-concurrent registration is negatively correlated with overall score in the course lecture, if hidden factors do not remove the correlation.

### **INTRODUCTION**

The science laboratory companion course is a tool that was originally implemented not only to offer students a hands-on experience with science that allows them to garner real-world skills, but also as a means by which to enhance and reinforce the content covered in companion lecture courses. The National Research Council defines the core purpose of laboratory courses in seven principal goals: “enhancing mastery of subject matter, developing scientific reasoning, understanding the complexity and ambiguity of empirical work, developing practical skills,

understanding the nature of science, cultivating interest in science and interest in learning science, and developing teamwork abilities” (Singer, Hilton, and Schweingruber, 2005). Notably absent from this description is mention of laboratory work as a means to support and reinforce lecture concepts. Indeed, few studies have actually focused on the initial claim of laboratories as a reinforcement of lecture material particularly in the context of the changing university laboratory environment of the twenty-first century (Hofstein and Lunetta, 2004).

Several studies published in the late 1970s and

early 1980s found that concurrent enrollment in science courses positively impacts student exam performance and overall attitudes, as well as overall grades, by as much as one-third of a letter grade, although no significant difference was found for the highest- and lowest-performing students (Saunders and Dickinson, 1979; Long et al., 1986). A more recent comprehensive study conducted in 2004 on over 9,000 students at the University of Michigan at Ann Arbor found that concurrent registration in general chemistry laboratory and lecture courses both (1) increased the odds of content retention more than two-fold and (2) increased the final grade score by nearly two-tenths of a point on a standardized four-point grading scale (Matz et al., 2012).

Many universities offer laboratory sections as a portion of a single course, indicating the distinct relevance to the subject matter for the principal purpose of developing deeper understanding of the course content (Bransford and Schwartz, 1999). In recent years, some universities have begun to decouple the laboratory and lecture components into separate courses that may be taken by students in different semesters, or, in some cases, the laboratory section is not required at all. The reasoning for this at the departmental level is to alleviate the high cost to the department to run such courses, particularly for students who may only need the lecture content to support work in another major (Dubravcic, 1979; Long, McLaughlin, and Bloom, 1986). On the student side, common belief is that decoupling the courses allows more flexibility for students in terms of scheduling concerns.

In this study, I examine performance data on 466 students enrolled in the Cornell University general genetics courses housed in the Department of Molecular Biology and Genetics. Both students and faculty consider the content extremely rigorous. Prior to the spring semester of 2013, a single five-credit course for introductory genetics was offered and was composed of both a laboratory and a lecture unit. In Spring 2013, the course was split into two components: a three-credit lecture and a two-credit labora-

tory. All students enrolled in the biology major are required to take both courses in order to graduate. Students may either enroll in both courses concurrently, or may opt to take the lecture first and the lab in a later semester.

The lecture portion of the course is taught by a rotating panel of professors in the Department of Molecular Biology and Genetics following a given general outline for content within the lecture. Lecture content is supplemented by an optional "problem-solving session" offered weekly by Teaching Support Specialist, Dr. Debra Nero, who also acts as a course coordinator for the laboratory portion of the course. Dr. Nero also has significant involvement with the teaching assistants for both courses and influences the grading of all exams, lab reports, and quizzes, though her direct jurisdiction is only over the laboratory course.

A panel of up to eight teaching assistants (TAs) per semester supports both courses. Each TA is responsible for the teaching of one laboratory section comprised of between 18 and 30 students. The TAs attend a weekly meeting focused on content and equilibrating grading practices so that the mean grades between sections do not fluctuate largely based on TA. The ultimate scores for both lecture and laboratory courses are curved to a "B" or 3.0 average, with specific numeric cut-offs fluctuating by semester.

## DATA AND METHODS

Data were collected on 458 students enrolled in the BioMG2800 lecture and between Spring 2013 and Spring 2014, including a summer semester. Of these, 179 students had completed the laboratory course BioMG2801 prior to the beginning of the Spring 2014 semester. All data was collected by course coordinator Dr. Nero, and de-identified prior to analysis. Gender, year in school, and overall GPA were not available.

Three major analyses were performed: (1) impact of concurrent registration on lecture grade, hereafter referred to as "lecture impact," (2) impact of concurrent registration on laboratory grade, hereafter referred to as "laboratory impact," and (3) survey of motivation for regis-

tration concurrencies, hereafter referred to as "motivation." All grade data was received as letter grades, including "+" and "-" categories, so as not to bias information based on changing semester totals and means. Each letter grade was transformed to a number on a four-point grading scale as follows: (A) 4.0, (A-) 3.7, (B+) 3.3, (B) 3.0, (B-) 2.7, (C+) 2.3, (C) 2.0, (C-) 1.7, (D+) 1.3, (D) 1.0, (D-) 0.7, (F) 0.0. A grade of "A+" only occurred seven times in the data set and was transformed to a 4.0 and included with the "A" category.

**Lecture impact.** All students were determined to be in one of two groups: (a) concurrent registration, consisting of 168 students and (b) non-concurrent registration, consisting of 299 students. It should be noted that group (b) includes some non-biology major students who are not required to take the laboratory course. These individuals were not marked in the dataset and therefore were not separated from the in-major students who did/will take the laboratory course in a later semester.

Data were entered as a matrix in R including lecture grade and concurrency (either concurrent or non-concurrent) and run through the linear model:  $\text{lecture\_grade} \sim \text{concurrency}$ . P-values below a cut-off value of 0.05 were considered significant to describe a difference in performance between the two groups.

**Laboratory Impact.** All students were determined to be in one of two groups: (a) concurrent registration consisting of 168 students, including all students enrolled in laboratory in spring 2013, and (b) non-concurrent registration, consisting of 11 students.

Data were entered as a matrix in R including laboratory grade and concurrency and run through the linear models:  $\text{laboratory\_grade} \sim \text{concurrency}$  and  $\text{laboratory\_grade} \sim \text{lecture\_grade}$ . P-values below a significance level of 0.05 were considered significant to describe an impact on performance.

**Motivation.** Finally, student motivations were assessed by survey to determine the predominant factors in a student's decision to couple

or decouple the courses. This data was not coupled to student identity and was therefore not assessed for impact on performance. Data was collected through a two-question survey using the Google Forms platform (questions seen in Table 1). Participation was offered to any student enrolled in lab in Spring 2013, Summer 2013, and Fall 2013, and was completely voluntary. 264 responses were collected.

## RESULTS

**Lecture Impact.** Using a simple linear model of concurrency, we do see that the concurrency status of registration has a significant impact on performance in the lecture section at a confidence level of over 97% (Fig. 1). However, the adjusted-R<sup>2</sup> indicates that, while there is a significant difference between the concurrency groups, the predictive power of the model is very low (0.008)(Table 2). Adding lab grade to the model increases the predictive power to a median level (0.3732) and greatly increases the significance level of the p-value; however, this is highly likely to be a byproduct of the low sample size of the non-concurrent group at the collection time of this data.

It is highly likely there are other important factors that greatly impact performance of the model that were not taken into account in this study. Other studies have suggested that overall GPA, year in school, and previous performance in related courses are valuable covariates in the model that will increase predictive power (Matz et al. 2012).

**Laboratory Impact.** Registration concurrency does not appear at the time of this data collection to have any impact on performance in the laboratory course. The p-value of the linear model was well above the cutoff value (Table 2). The adjusted-R<sup>2</sup> is extremely close to 0 and slightly negative, indicating that this model is a very poor fit to the data (Fig 2). This value may be improved upon inclusion of additional data points in the non-concurrent cohort.

However, lecture grade and lab grade do show a significant correlation with a moderate

adjusted-R<sup>2</sup>, indicating better model fit than the other analyses. This is likely to be a byproduct of overall student ability: a student who consistently performs in the 4.0 range will be very likely to perform in the 4.0 range in these courses, while a student who consistently performs at a 2.0 is likely to perform near a 2.0 in these courses. This effect could be accounted for by the inclusion of overall GPA as an element in the model. Additionally, the Pearson's product-moment correlation coefficient (*r*) was consistent between all concurrencies (0.63) and concurrent (0.62), but not consistent for the non-concurrent group (0.44)(Fig 2).

Finally, there was a slight shift in the means of the concurrency groups to the effect of 0.15 grade points less for the non-concurrent registration group (Fig 3). However, the *p*-value for the difference between the means was non-significant at 0.498, so the shift is likely only due to small sampling size in the non-concurrent group and the overall spread of the data does not reflect a true shift in the mean of the grades based on concurrency type.

**Motivation.** Of the 264 students who took the online anonymous survey about motivation for registration concurrency, 49 individuals indicated they took the laboratory and lecture non-concurrently (Fig. 4a). This cohort is likely comprised predominantly of individuals who enrolled in the laboratory section in Spring 2014 and for whom laboratory grade data was not yet made available. Additionally, as the survey was sent to over 600 individuals, it suggests there is a high likelihood that more than 40 additional non-concurrent data points may be collected for the laboratory after the conclusion of the Spring 2014 semester.

Overwhelmingly, students who were enrolled concurrently believed that this enrollment choice would positively affect their grade (Fig 4b). This is in alignment with the beliefs of the course coordinators and fits in with the course objectives of supporting and reinforcing lecture concepts through hands-on laboratory techniques and experiments. The second largest choice for concurrent enrollment was

“scheduling.” While this option comprised 29% of the responses, students frequently answered “graduating” and “I wanted to get it over with” as responses to the “other” section, which may be considered a scheduling reason. This increases the frequency of scheduling concerns to 34.6%. Additional responses in the “other” category were largely sarcastic and/or uninformative answers (e.g., “I like to tickle flies.”)

For non-concurrent registration, 71% of students were largely concerned with the workload requirements of the course (Fig. 4c). In this group, the write-in “other” category was largely comprised of students who originally enrolled in the courses concurrently, but found the workload between the two courses to be concerning, and ultimately dropped the lab course during the semester in which they had enrolled in lecture, opting to take it at a later date. Additional responses in the “other” category were largely related to administrative issues such as transfer credit for lecture, but not for laboratory.

## DISCUSSION AND FURTHER RESEARCH

The data presented here seem to suggest there may be some correlation between lecture or laboratory performance and concurrency that is difficult to ascertain due to hidden factors in the data that were not assessed by this study. The principle hidden factor that was not available at the time of data collection that would be most informative to future iterations of this analysis is the inclusion of student's overall GPA and/or overall science GPA. These overall performance scores are likely to be most highly predictive in the highest- and lowest-performing students, with greater variability in students performing at the center of the range.

Additionally, this study suffered from extremely small sample size in the non-concurrent group as compared to the concurrent group, thus limiting the strength of the conclusions that can be drawn from the data. The validity of the reported findings can be strengthened or negated by the results of repeated study after a significant increase in data collection.

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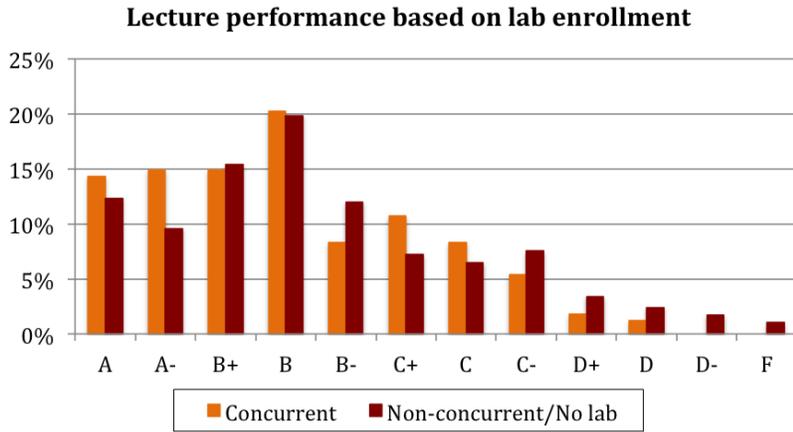
## FIGURES

**Table 1.** Registration concurrency motivation survey

Did you take the BioMG 2801 laboratory in the SAME SEMESTER as the lecture?	Yes	Why did you choose to take these courses in the same semester?	Scheduling reasons
			I believed being in laboratory supports the concepts in lecture and would help my grade
			There was no option when I enrolled to take them separately
	Other		
Did you take the BioMG 2801 laboratory in the SAME SEMESTER as the lecture?	No	Why did you choose to take these courses in separate semesters?	Scheduling reasons
			I believed the workload was too great for the two courses to take them in the same semester
			Other
	Other		

**Table 2.** Linear model results

Analysis	Adjusted-R squared	P-value	Sample size
lecture_grade ~ concurrency	0.008364	0.02793	458
lecture_grade ~ concurrency + lab_grade	0.3732	2.20E-16	179
lab_grade ~ concurrency	-0.003036	0.4979	179
lab_grade ~ lecture_grade	0.3762	2.20E-16	179



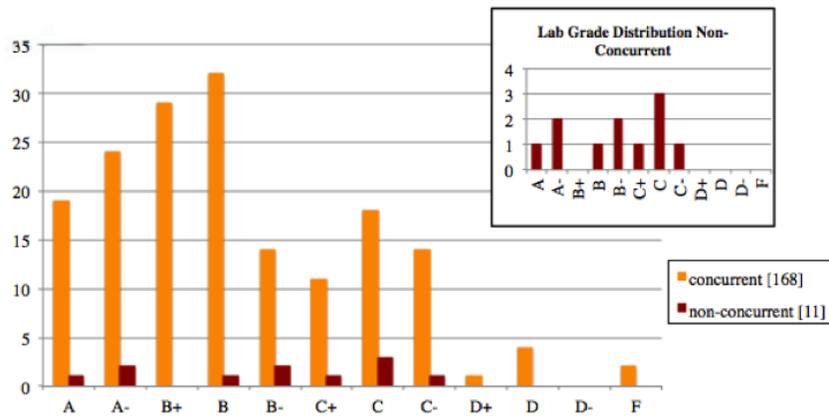
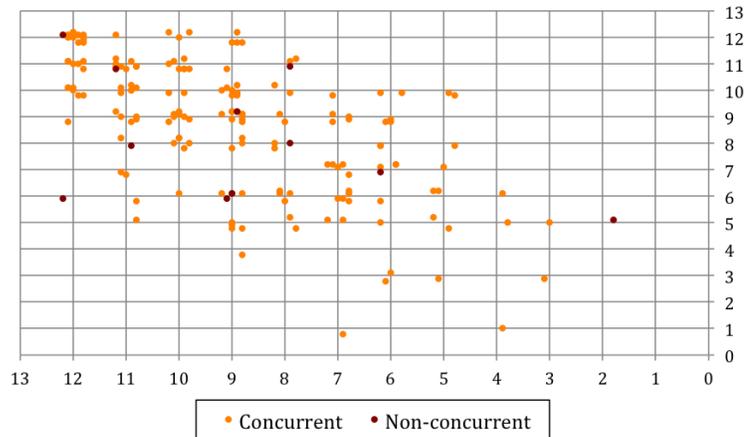
**Figure 1.** Lecture performance by concurrency

Distribution of lecture grades by lab registration scaled to percentage of total. Individuals comprising the non-concurrent/no lab group may be of one of two types: (1) they are taking the lab non-concurrently, or (2) they are not required to take the lab. SD concurrent= 0.75, SD non-concurrent= 0.88.

**Figure 2.** Distribution of grades in lecture and lab based on concurrency

Correlation between lab and lecture scores over all concurrency formats is 0.62. Correlation over concurrent is 0.63. Correlation over non-concurrent is 0.44. NOTE: Grades have been jittered by +/- 0.2 for visibility. Letter grades corresponded to a 12 point scale beginning with A [12] and ending with F [1].

**Performance in lab and lecture by concurrency**



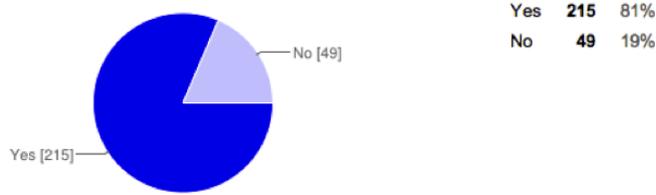
**Figure 3.** Lab grade distribution by concurrency

Distribution of non-concurrent lab grades at 1 student scale in inset. Mean difference p-val = 0.498.

**Figure 4.** Survey on motivations behind registration concurrency

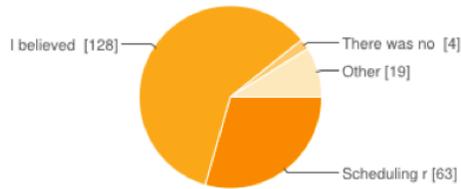
**A.**

**Did you take the BioMG 2800 lecture in the SAME SEMESTER as the BioMG 2801 Laboratory?**



**B.**

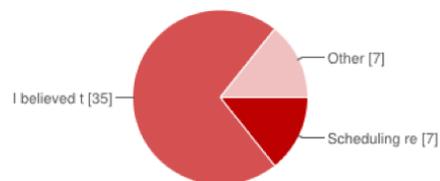
**Why did you choose to take these courses in the same semester?**



Scheduling reasons	63	29%
I believed being in laboratory supports the ideas in lecture and would help my grade	128	60%
There was no option when I enrolled to take these courses separately	4	2%
Other	19	9%

**C.**

**Why did you choose to take these courses in different semesters?**



Scheduling reasons	7	14%
I believed the workload was too great for the two courses to take them in the same semester	35	71%
Other	7	14%

# The Impact of Laboratory Research Experience on Undergraduates: A Case Study

**Stephanie Parker**

**Biomedical Engineering, Cornell University**

## **Abstract**

The purpose of this case study was to qualitatively examine the impact of participation in laboratory research on a particular group of undergraduates. The study is based on observations, interviews, and surveys of six undergraduate research students working in a food science laboratory. Students reported research to be more complex and unstructured than expected. Students also expressed discomfort with the complex nature of planning their own research project. In response, the students suggested that instruction on reading scientific papers and more guidance on understanding the intellectual merit of their projects would be a beneficial component to the undergraduate research experience. Students reported that a key component to the success and positive impact of their experience stemmed from one-on-one mentoring of senior lab members. In addition, the collaborative laboratory environment provided students with a positive group work experience and highlighted the importance of cooperative project execution.

## **INTRODUCTION AND LITERATURE REVIEW**

Research is not a required component of undergraduate curriculum, but it can serve as a valuable way to supplement classroom learning. Currently, at the undergraduate level, many scientific courses are often offered with a laboratory component. However, in contrast to conducting research, standard laboratory courses do not allow students to explore the applications of the laboratory techniques as well as trouble shoot or optimize procedures. Undergraduate research may also serve as a potential pipeline to graduate school. Presented in this paper is an evaluation of how undergraduate research experience may be beneficial in not only supplementing undergraduate education but also in motivating students to pursue graduate degrees. Further, the lessons learned

and observations of unanticipated consequences of laboratory research participation from the students are examined.

Undergraduate research experiences are promoted as opportunities to engage students and motivate them to pursue graduate degrees. The importance of undergraduate research experience has also been reflected nationally in the many National Science Foundation (NSF) funded Research Experiences for Undergraduates (REU). These REU programs are supported at universities and laboratories nationwide, an initiative that began in 1987 (Foundation, 1996, 2014). National support for research is also a result of the concern that there is a national trend toward a shortage in the number of skilled researchers. As stated by Hunter et al., "The demand for talented researchers is quickly

outpacing supply. This trend has worried many policy makers, scientists, educators, and politicians, and has encouraged them to find new ways to attract young students into research" (Hunter, 2007).

Working in a research lab provides students with an opportunity to receive instruction from faculty one-on-one and in a less structured and informal setting. A study at the University of Delaware surveyed 2,444 students and found that the students who participated in undergraduate research are more likely, by 15-30%, to pursue graduate degrees. Students also reported that faculty members had an important impact on their choice to pursue further education (Zydney, Bennett, Shahid, & Bauer, 2002). In addition to prompting students to pursue higher degrees, this interaction with faculty has the potential to positively impact students' ability to be successful in obtaining acceptance into graduate school. A study done at Northern Arizona University in the psychology department found that the acceptance rates for students who participated in undergraduate research under the advisement of faculty was nearly 100% (Wayment & Dickson, 2008).

Further, working on research projects and meeting consistently with faculty members is an excellent opportunity for students to develop the tools needed to pursue graduate degrees and careers in research. A group found that students who met with faculty and worked on a research project after the experience were more able to think scientifically, understand scientific research, synthesize information from diverse sources, and take more initiative in framing and solving research problems (Thompson, Alford, Liao, Johnson, & Matthews, 2005).

In this way, undergraduate research offers students an opportunity to supplement their academic coursework with practical experience. Coursework tends to be oversimplified when compared with the complexity and open-ended problems professionals encounter in practice (Sabatini, 1997). Research experience exposes students to open-ended problem solving, teamwork, and requires students to explore creative

and innovative solutions to problems. To determine the education and professional impact of undergraduate research experiences a survey was developed by Lopatto in 2004, Survey of Undergraduate Research Experiences (SURE), which is currently in its third iteration (Lopatto, 2010). The survey was administered to 1,135 participants and included 20 evaluative questions that students rated based on the potential educational gains of their previous research experience. The study found that the highest rated items included: "understanding of the research process in your field," followed by "readiness for more demanding research," "understanding how scientists work on real problems," and "learning laboratory techniques" (Lopatto, 2004). Research experience thus has the potential to supplement undergraduate coursework learning by preparing students for future careers and providing introduction to real-world problem solving.

Mentorship by senior lab members can also prove critical to success of the undergraduate research experience. The traditional model of research in which a faculty mentor provides advisement to undergraduate researchers may be impractical due to teaching commitments and the disproportionate student-to-faculty ratio (Seymour, Hunter, Laursen, & DeAntoni, 2004). Graduate students are able to provide undergraduates with supplemental resources to assist them in comprehending the purpose and relevancy of their research (Faurot, 2013). Further, there is national support and advocacy for mentorship of undergraduates by graduate students. In a report published by NSF, the foundation promotes and supports universities in providing graduate students with opportunities to mentor undergraduate students (Foundation, 1996).

The purpose of this study was to determine how undergraduate research supplements coursework learning in a research lab at Cornell University under the supervision of Dr. Carl Batt. Specifically, the goal was to determine how valuable the students found the experience and how it supplemented their classroom learning. In addition, the students were asked about the

experience of research, how their perceptions have changed, what tools they feel were critical to their success, and how the experience could be improved.

## **BACKGROUND**

Cornell University offers students the opportunity to add breadth and depth to their undergraduate experience in the form of conducting research for course credits. The students in this study all received course credit for research hours during the academic year. In addition, some of the students elected to volunteer to continue research during the summers. The students are majoring in programs in the science, technology, engineering, and mathematics (STEM) fields. Their majors include Human Ecology (Pharmacology), Biomedical Engineering, and Food Science.

To assist and train the undergraduates in the laboratory, in addition to advisement of the principal faculty advisor, graduate students and postdoctoral associates mentored the students. The mentors have expertise in Chemical Engineering, Mechanical Engineering, Biomedical Engineering, and Biochemistry. The projects that the undergraduate students worked on focused in the areas of microbiology and biomedical applications, and are directly related to their fields of study.

Students were required to spend three hours per course credit per week conducting research, attending weekly group meetings, and occasionally presenting their research findings and progress during lab meetings. The process of assigning research projects for the undergraduate students required first an initial training period working with a senior lab member. Next, the students were assigned individual projects to complete by Dr. Batt, with continued mentorship and training by senior lab members.

To keep track of their progress, in addition to lab meetings, students were required to post bi-weekly on the Batt lab online group collaboration webpage (Wiggio.com), outlining the experimental work they planned to accomplish

during the next two-week period. This online group site was also where the students can share information about their projects and post supporting texts and protocols.

## **METHODS**

Two assessment methods were used to examine the benefits the students garnered during their undergraduate research experience; we used a methodology adapted from a previous study (Sabatini, 1997). First, students took an initial seventeen question survey which included; (a) demographic information: year in school, gender, semesters of research experience, research conducted in other laboratories, and the number of research credits enrolled in for the current semester, (b) Likert scale questions, which on a 5-point scale asked them to rate the benefits of conducting research in relation to skills obtained, and (c) open-ended questions: detailing motivation, resources used during research, mentoring experience, and major lessons learned. This presented common themes among the students' experience to be used for further discussion. Following the survey, all of the six students participated in a focus group discussion on the research experience facilitated by the first author of this paper, a graduate student mentor in the lab. During the focus group the students talked about their experience, the lessons learned, and offered feedback on how the experience could be improved.

Of the six students surveyed in this study the demographic breakdown was as follows: Gender: two male, four female; Class Standing: one freshman, two sophomores, and three seniors; and Semesters of Research Experience: three with one to two, one with three, and two with four or more semesters, as outlined in Table 1.

## **RESULTS**

Students were asked about their initial motivations for conducting research and reflected on the key sources and benefits that they perceived to be the most impactful educationally and toward their development as researchers. Results presented here are broken up into sec-

**Table 1.** Demographic breakdown of study participants.

Gender	
Male	2
Female	4
Class Standing	
Freshman	1
Sophomore	2
Senior	3
Semesters of Research Experience	
One to Two	3
Three	1
Four or more	2

tions including motivation, perceived benefits of conducting research, and common themes related to: how their ideas about science/research changed as a result of being involved in research, how the experience of conducting research in the lab can be improved, major advantages of the undergraduate research experience in relation to academic learning, and most helpful resources.

**Motivation.** On the survey, students were asked about their motivation for pursuing undergraduate research for course credits. The reported motivations given included a desire to pursue graduate study, intention of pursuing a career in research, opportunity to learn what research is, and opportunity to include research along with course-work studies. One of the students was in a research scholars program and was required to conduct research as a condition of his funding. Another student reported that her motivation was also related to her decision to study at a research institution of higher education.

“The reason that I wanted to go to a university (over a college) was for the opportunity to engage in research. It is one thing to learn everything in a classroom and reproduce it on an exam and get good grades, but it’s another thing to actually work towards making a difference in the world.”

For this student the environment of the research university setting exposed the students to research they might not otherwise have gotten at a smaller college (hence their reason for selecting a research university in the first place). This speaks to the importance of providing graduate students the opportunity to conduct research.

The sometimes conflicting demands of research and teaching has led to an ongoing debate regarding whether or not research improves teaching in higher education. Empirical studies show that the existing link between research and teaching is weak (Bordogna, Fromm, & Ernst, 1993). In this instance, it seems that at least the perception of the student is that a research-focused institution will provide exposure to groundbreaking research that may not be as easily accessible to students attending more teaching-focused universities. In addition, the student quoted above expressed that she believes that conducting research will supplement her undergraduate education by providing context and introduction to innovative scientific techniques and areas of study in ways that are not available through coursework.

**Perceived Benefits of Conducting Research.**

On the survey, students rated how they felt about conducting research and the degree to which their participation in research enhanced their skills in oral presentation and experimental design, and the degree to which it cultivated knowledge of their respective fields, motivation to continue on to graduate school, and understanding of how to stay informed of recent advancements. The benefit levels ranked high in all of the areas, with average scores greater than 4 (4= agree), except in the category of understanding of how to stay informed of recent advancements in the field (see Table 2), which indicates that, in practice, students may be able to conduct research and report their research findings, but they still have a narrow understanding of the research community. This suggests that the students are missing in depth understanding of their role as a researcher and how they are connected to the larger research community, outside of their laboratory and university. To

probe more deeply into this finding, the focus group included a discussion on the skills that the students felt would be needed to assist them in being more knowledgeable of recent research advancements. The outcome of the discussion is included in the section on how the experience could be improved.

**Table 2.** Likert Scale Survey Question Results (1 = strongly disagree, 2= disagree, 3 = neutral, 4 = agree, 5= strongly agree).

I have benefitted from research in the following areas:	Average Value (n=6)
Oral presentation skills	4.17
Experimental design	4.50
Confidence in my knowledge of my field of study	4.33
Motivation to continue on to graduate school	4.83
Understanding of how to stay informed of recent advances in my field	3.83

**Common Themes.** For the focus group discussion, students elaborated on their responses to the survey. Further, the survey responses presented the common themes as expressed by the students that were used for further discussion, as outlined in Table 3.

Students find lack of structure challenging and frustrating: Need for scaffolding. When asked how their perception of research changed as a result of their research experience, survey results reported that students found research to be much more difficult, frustrating, and complex than expected. Students’ previous experience with lab work consisted of formulaic lab classes where procedures were already laid out for them and they were only expected to follow directions and report the results. That was the expectation they had when entering the lab. One student explained that she “thought there would be instructions for everything” and another student articulated that he “did not

expect to think on [his] own.” Another student explained that she “wanted to do cancer research, [but] didn’t realize all the work that would be put in” and that she did not realize that she “needed to know all the steps before starting work.”

This response is directly related to the students being given their own research project to be responsible for, which was not what they expected coming in. Students had assumed that they would be working for a graduate student on a project, and not that they would have to plan out their own experiments. Students indicated that planning and executing experiments was not required in their coursework lab classes and was therefore unfamiliar to them. It seems as though students need some scaffolding at least early in the laboratory process. This provides evidence that conducting research augments coursework learning via the development of skills such as problem solving and experimental design, which the students might not develop through taking courses.

Students crave more structure—at least initially. Following the theme that students found research to be difficult and ambiguous, they also expressed how they felt that the experience could be improved upon. Students believed that a research experience that was more structured, providing more guidance and opportunities to present research, would be beneficial. Table 3 outlines the major points the students determined would improve the experience of working in the lab. The suggestion that more structure is needed indicates that they are uncomfortable with designing and implementing their own research plans.

Further, the students compiled a list of areas in which they would like more instruction. The list included: learning how to read papers and figure out which experiments to do, understanding the intellectual merit of experimental work and where the field is going, how to write a paper, and more structured group meetings. In this instance the students communicated that they lacked the skills required to assess the work of other researchers and determine how

previous work related to their own studies.

Additionally, the unstructured nature of research led students to feel uncomfortable, and students expressed that they had difficulty understanding the intellectual merit of their research. Supporting my results, Kardash (2000) surveyed faculty mentors and undergraduate researchers to measure the perceptions of their research experience. The Kardash study found the lowest ratings for the two following areas: skills needed to make use of research literature and relating one's research to the big picture and writing a research paper (Kardash, 2000). Thus, undergraduate research can facilitate an introduction to the scientific research field, but it usually does not result in students' immediate transition into independent researchers.

However, students' ability to reflect on and identify the skills that they are lacking shows that their experience has the potential to provide a basis for technical understanding. In addition, the awareness of the missing skill set provides an opportunity for them to seek out guidance in the areas that are required for higher order intellectual engagement. Further, mentors in the laboratory and faculty members with whom students interacted during their research experience are valuable resources for this guidance.

#### Major advantages of the undergraduate research experience in relation to academic learning.

In reference to how conducting research in the lab supplemented their classroom learning, students responded that research solidified the concepts that they were learning or had learned in their courses. They gave examples of concepts that they had learned in class and but did not fully understand before running experiments in the lab, and examples of concepts they learned in the lab and later covered in coursework that they would not have understood in depth if they had not had the experience in the lab. One student explained, "In class I only remember what I need for the test... [I] didn't fully understand the information." In addition, working in the lab provided an application for the concepts or techniques learned in class.

One student explained that conducting research "solidifies what [is] already learned in class" and "connects multiple topics and a reason [students] have to know it."

In coursework studies, students have had trouble connecting what they learn in class to real life practice, and working in the lab provides them with context. Even with classes that have a lab component, students felt that they lacked the time to understand procedures and learn from potential mistakes in the class lab time. They explained that they were "more focused on the grade and leaving" the lab, while in "the research lab [there was] more responsibility for [the] project" instead of merely "following directions and memorizing information." One student explained the difference between conducting research in the lab and class lab is that "you have to know what you are doing--you can't just go through the motions."

In addition, students felt that the collaborative environment of working with other researchers was a positive example of group work that was not similar to their experience of group work in a class setting. In the lab, although all of the students had their own individual project, they often had to rely on the assistance of other lab members to accomplish tasks in the lab. One student explained, "In group projects in class, everyone comes in without knowledge on the subject, but in lab people have previous knowledge and can contribute."

In addition, they acknowledged that all of the students in the lab chose to be there and were motivated to work on their own project and were willing to assist others, which contributed to the positive cooperative environment. From this experience the students felt that they learned that research requires a collaborative effort.

#### Graduate student mentoring viewed as most valuable.

The students agreed that the most helpful resource during the research project was the one-on-one mentoring of the graduate students and post-doctoral fellows, as well as the other senior undergraduate researchers. They felt that

**Table 3.** Common themes resulting from survey and focus group discussion.

Common Themes	
<b>How have your ideas about science/research changed as a result of being involved in research?</b>	<b>Research Is: Frustrating, Ambiguous, Time Consuming, and Challenging</b> <ul style="list-style-type: none"> <li>• “[...] better understanding of how long everything truly takes [...] I thought things happened a lot faster.”</li> <li>• “I have realized that it can often be frustrating.”</li> <li>• “I realize that published results aren’t as black and white as they seem and there is room for modification/improvement in any experiment.”</li> </ul>
<b>How can the experience of conducting research in the lab be improved?</b>	<b>More Structure, Guidance, and Opportunities</b> <ul style="list-style-type: none"> <li>• More opportunities to present research</li> <li>• Instruction on how to read papers and figure out what experiments to do</li> <li>• Guidance on understanding the intellectual merit of projects in the lab</li> <li>• More guidance on how to learn about where the field is going</li> <li>• Instruction on how to write a paper</li> </ul>
<b>Major advantages of the undergraduate research experience in relation to academic learning?</b>	<b>Supplemental Learning, One-on-One Mentoring in Laboratory Setting, Positive Collaborative Group Learning Experience, and Increased Motivation</b> <ul style="list-style-type: none"> <li>• Supplements materials covered in courses. Opportunity to perform lab activities one-on-one with mentor.</li> <li>• Hearing the things in context and in practice are helpful.</li> <li>• Being responsible for a project increases motivation and forces students to understand all aspects of project</li> <li>• Advantages over coursework experience: <ul style="list-style-type: none"> <li>• In classroom labs, students don’t understand procedure in depth and feel they need to memorize without completely understanding information</li> <li>• Positive experience of group work, compared with groups from classes</li> </ul> </li> </ul>
<b>Most helpful resources?</b>	<b>Mentoring and Collaboration</b> <ul style="list-style-type: none"> <li>• Talking with graduate students is the most helpful.</li> <li>• Experience from graduate students helps in explaining things.</li> <li>• Collaboration is important to research.</li> </ul>

the senior researchers were able to explain concepts in a manner that was “concise” and more “specific” compared to previous explanations of laboratory techniques in courses. The senior students also had the experience of both the mentee and mentor. As the mentee they appreciated learning the laboratory techniques from a peer and as a mentor had the opportunity to explain techniques and answer questions for the other students in the lab. Mentors were able to assist the students in getting started with their project and provide them with guidance during the process. This highlights the benefit of working with a mentor in undergraduate research experiences for gaining technical proficiency.

Motivation to continue on to graduate school.

Despite the challenges that the students associated with the research experience, when asked about whether conducting laboratory research has motivated them to continue on to graduate school, five of the six students agreed or

strongly agreed (Table 2). Three of the students that were seniors during the 2013-2014 academic year plan to attend graduate school in the upcoming fall semester. All three of the students were successful in obtaining admission to graduate school and all three of the students received letters of recommendation from their advisor and mentor Dr. Batt. One of the students will be entering a Ph.D. program and two of the students will be entering Masters’ programs in engineering in the coming Fall 2014 semester.

**DISCUSSION**

Undergraduate research students were surveyed and a focus group was conducted with six current students to determine the educational and practical impacts of the undergraduate research experience. Students reported a range of motivation for opting to conduct research in addition to their coursework studies, including: desire to engage in research, understand how

research is done in their field, prepare for graduate school or a future career in research, and to fulfill a research requirement.

One of the common themes presented by the students was that they found research to be more difficult and unstructured than anticipated. Students came in expecting research to be similar to lab courses, where they would follow a given procedure and achieve the expected results. However, their experience in the lab brought them to the realization of the complicated nature of research. Students also expressed that working in the lab reinforced material learned as part of their undergraduate coursework. However, in courses, the students felt memorizing information for an exam was sufficient, while in the lab the students felt that they had to understand the science to be successful. Thus, research provides an opportunity to augment their coursework learning with instruction that was not offered with traditional studies (Sabatini, 1997). It also introduces students to the research field and helps them identify the skills required to enter a career in research or continue on to graduate school.

Although students felt that they had learned about the process of research, they did not feel that practical experience in the laboratory allowed them to garner the skills needed to stay abreast of the technological advances in their fields. Further, the students still have a narrow understanding of the research community. This is directly related to their inability to assess previous research and was indicated by their suggestion that they would like more instruction on how to read scientific papers. Students also communicated that the "intellectual merit" of their research was unclear to them and that they would like more guidance to understand this. This finding is in agreement with previous studies that assessed the impact of undergraduate research experiences and found benefits in technical proficiency but little in the area of intellectual proficiency (Feldman, Divoll, & Rogan-Klyve, 2013; Kardash, 2000; Lopatto, 2004).

However, the students' ability to reflect on the skills that they are lacking and recognize how

those skills would be useful is directly related to lessons learned during their research experience. Without exposure to research students would not be aware of the necessity and the level of their deficiency in the area of understanding research in their field. With knowledge of the tools required to become an intellectually proficient researcher, the students have the ability to seek out training in these areas. More can also be done on the part of the advisor and mentors to facilitate development of these skills; however, this will also require the undergraduate students to be more proactive in their interaction with mentors and peers.

Students also directly benefited from one-on-one mentoring and the collaborative work environment. Students reported that the most helpful resource for their research project were their graduate student or post-doctoral mentors. Students also appreciated collaborating with their peers and learning from each other in a positive group environment.

In addition, the students rated motivation to pursue a graduate degree highly as a result of their research experience. Despite the experience being different and more challenging than expected the students did find that the experience was beneficial, and they were encouraged to pursue research further. Thus, the experience not only provided the students with practical knowledge, but also increased their interest in science. As evidence, three of the students surveyed in the study will matriculate to graduate school programs in the coming fall and the other students plan to continue to pursue undergraduate research.

## CONCLUSIONS

The results of this study suggest that undergraduate research experience can positively impact students' educational training and increase their career interests in research. It is also a unique opportunity for students to learn skills that they would not develop as a result of taking courses. The practical experience alone does not provide them with the skills required to understand how their research is applicable

to their field. It does however allow students to discover areas in which they are lacking and require further training in relation to research. Further, without exposure to research they may not have been aware of their deficiencies in these areas. Mentoring was also greatly appreciated and played a key role in their success.

The conclusions made as a result of this study are limited due to the low number of participants at a single institution. However, the small study size and unique vantage point of the researcher did allow for a more in-depth analysis of student responses through the focus group discussion and observations. Additionally, many of the themes and conclusions agree with previous studies conducted on larger groups. Future work could include feedback from the mentors and faculty of the lab and also follow students throughout their experience and monitor their progress in graduate school.

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# Analytical Chemistry of Beer: A Research-Based Lab Project

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## INTRODUCTION

**Personal Motivation.** In six semesters as a graduate teaching assistant, I mentored undergraduate chemistry majors during their last two laboratory courses in their baccalaureate program. The laboratory assignments in both of the courses were quite traditional. Students received lab handouts that outlined specific steps to arrive at a predetermined result. In six semesters as a teaching assistant for these traditional labs, my observations were that students rarely thought deeply about what they did in lab until weeks later when the lab report due date neared. This thoughtlessness in lab contrasted with my interactions with students, which revealed the students' ability to think deeply and critically. My deep conviction was that these labs were missing precious opportunities to form talented chemists.

**Department Context.** Chemistry has often been called the central science because chemistry underpins many other sciences and spans the gaps between microscopic and macroscopic views of the world. For curriculum developers, this centrality is a blessing and a curse. Chemistry can explain diverse pieces of nature, but the diversity presents challenges in covering the many necessary topics and connecting chemistry to each specific discipline. For Cornell's Department of Chemistry and Chemical Biology, this challenge has put great pressure on the Chemistry curriculum. In order to allow undergraduate chemistry majors to explore the many different sub-disciplines within Chemistry, the

core Chemistry classes have been compressed. In order to make room for more specialized sub-discipline courses, the sophomore-level "Quantitative Chemistry Lab" and junior-level "Analytical Chemistry Lab" were combined into a single junior-level lab as of Fall 2012. This curricular overhaul provided a unique opportunity to institute pedagogical reforms in the laboratory classroom. The goal of this project was to take advantage of this temporary upheaval of the status quo to propose pedagogically progressive laboratory curricula.

**Instructor Concerns.** When implementing a new inquiry-based lab curriculum, teachers reported concerns in four major categories: evaluation, information, management, and consequence (Cheung, D. 2007, p. 107). In response to the proposed curricular innovation, the professor in charge of the Honors Analytical Chemistry Lab course responded with concerns in Cheung's categories (see the following table). In evaluation concerns, the teacher felt that no innovation was necessary for the course. Furthermore, he felt that research-based projects were not feasible scientifically or logistically. In a management concern, the teacher felt that there would not be enough class time for a research-based project and that the project would increase professor and teaching assistant workload. Finally, the teacher had consequence concerns, meaning he felt that labs should have a predetermined outcome to ensure the students achieve content knowledge.

**Table 1.** Descriptions of instructor concerns

Concern Type	Description
Evaluation	Teacher feels uncertain about the worthiness and feasibility of implementing the innovation.
Information	Teacher is uncertain about the demands of the innovation and his/her role in it.
Management	The teacher is concerned about efficiency and time demands.
Consequence	The teacher is concerned about the impact of the innovation on student learning and his/her professional development.

**Research Questions.** This pilot project is designed to address the above teacher concerns. In particular, the research questions are:

- Is the research-based project feasible scientifically, logistically, and financially
- How do the students respond to freedom and responsibility of the research project?
- What are the benefits to the students, teaching assistant, professor, and department?

## LITERATURE REVIEW

**Laboratory Instruction Styles.** Even within a department, the goal of a lab course can be a matter of personal taste. In fact, educators worldwide continue to debate over the ultimate goal of the laboratory course. A recent European standard called for undergraduate chemistry laboratory work to teach students to carry out a standard protocol rather than plan an investigation to address a specific problem (Tiberghien). In contrast, the American Chemical Society calls for laboratory courses to transition from the freshman-level repetition of standard procedures to senior-level autonomous investigations of specific problems (ACS).

In truth, there are many different goals for lab courses. The key is to design the lab assignment to match the desired goal. The different types

of laboratory assignments are summarized in Table 1. Each of these is designed to reach a different goal. Traditional chemistry labs are dominated by expository labs, a.k.a. “recipe-style” labs. The expository lab resembles a cookbook, in that a given procedure with a deductive approach to reach a predetermined outcome. The goal of these labs is to verify concepts discussed in lectures. Unfortunately, there is debate on whether this happens. These recipe-style labs have been criticized in the literature as requiring very little thinking, being ineffective in teaching students new concepts, and portraying an unrealistic picture of scientific experimentation (Domin, 1999).

**Table 2.** Descriptors of the laboratory instruction styles

Style	Descriptor		
	Outcome	Approach	Procedure
Expository	Predetermined	Deductive	Given
Inquiry	Undetermined	Inductive	Student generated
Discovery	Predetermined	Inductive	Given
Problem-based	Predetermined	Deductive	Student generated

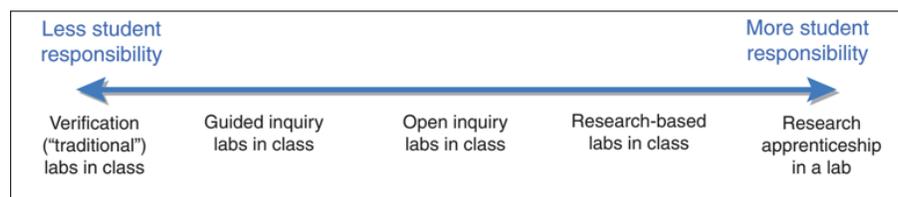
Ideally, a laboratory curriculum will contain a variety of lab styles. Inquiry labs call for the most autonomy. Students must generate their own procedures to study problems with undetermined outcomes. The inductive approach also means that their experience drives their understanding of the general principles. Inquiry-based labs have been found to drive the greatest learning gains, especially in higher order cognitive skills. But warnings need to be heeded about giving students too much autonomy too soon (Kirschner, 2006).

Discovery labs are particularly attractive for teachers who want to modify existing expository labs. The procedure is still given, but the undetermined outcome and inductive approach means that the students derive the general principle from their specific experience.

Problem-based labs allow students to generate procedures based on a deductive approach to reach a predetermined outcome. These types of projects allow students to solve real-world problems within a controlled context (McDon-

nell). The main advantage is the increased student interest and motivation to tackle a focused problem.

Ultimately, I believe the laboratory curriculum needs all of these lab styles. Just as Bloom's taxonomy describes learning as a pyramid of lower-level learning building toward higher-order cognitive skills, these lab styles should also be seen as developmental steps in equipping independent chemists (Bloom, Andersen). The key to choosing which lab design to implement is to critically examine desired student out-



**Figure 1.** Inquiry and research exist on a continuum, from a pure verification experience in class to a full-fledged research experience. The levels of student intellectual autonomy and responsibility increase from left to right.

comes. Many useful rubrics measuring higher-order cognitive skills, the nature of science understanding, and communication skills have been developed to complement the more common testing of content knowledge (Kishbaugh).

One major reason for the lack of consensus on lab courses is the uniqueness of each department. Lab instruments and manuals are often a function of the particular teachers in the department and are rarely based on outside curricula. Consequently, there have been disagreements in the literature on how to categorize less traditional lab assignments within and outside of Domin's structure. In particular, "inquiry" has become a buzzword with laboratory curriculum developers. Rubrics have been developed to help identify exactly which labs are "inquiry-based" (Buck, Fay).

A simpler way to characterize the different lab types is to consider each lab on a continuum of student responsibility (Figure 1). On the one end, students follow recipes to verify results already discussed in class. On the other end, students carry out independent research proj-

ects in a research group. Non-traditional labs fall somewhere in between these two extremes, depending on the amount of student responsibility. The project in this paper gave students widespread autonomy and models what "research-based labs in class" can look like.

## METHODS

**Pedagogical Research Methods.** The richest source of pedagogical feedback throughout this project was participant observation as I interacted often with the students throughout

the project. As a near-peer (graduate student), I was able to interact easily with the students and observe their motivations and learning processes. Observation was also necessary, because I found that my preconceived notions about how and what they were learning were

heavily influenced by my position as someone interested in academic research. The students' interests and plans for the future were much broader and therefore they thought very differently about the project than I. Any quantitative surveys that I designed could not have examined the complexity and depth of experiences that the students shared with me. I took field notes of my observations and analyzed them for themes that emerged, looking for outliers and inconsistencies as well as consistencies within the groups.

At the end of the semester, I asked students for a one-page reflection paper describing what they had learned or gained from the project. The purpose was to help them reflect and also to validate my own observations. Quotes included in this article are from these reflection papers or from my conversations with the students.

**Teaching as Research Project Design.** In hopes of effecting curricular innovation within the chemistry department, this pilot project was proposed. As a pilot, this project's main

goal was to demonstrate the feasibility of conducting such a challenging project within an undergraduate lab course. The chemistry department raised concerns that this project would be too time-consuming and logistically too complex to be feasible as part of the lab course. These concerns have been seen when instituting inquiry-based labs in other locations as well (Cheung). Success of this pilot allayed these concerns and addressed many unforeseen logistical problems.

***Ithaca Beer Company.*** A connection pointed me toward the Ithaca Beer Company, a local craft brewery. When I toured the brewery and talked to one of the brewers, the potential for collaboration was immediately apparent. The brewery had many questions that analytical chemistry could answer. After the first introductions with the students, the next meeting was at the brewery. The brewery's lab manager gave the students a tour, which really excited the students. The brewer was really impressed with the great questions that the students asked. He gave them two beer samples: one in the middle of fermentation and one finished beer. This was really the start of the experiment. The differences in taste and smell of the two beer samples were really the origin of the experiments and started the project off with a really engaging experience for the students. The motivation of these kinds of "field trips" has been seen in other chemistry lab courses (Forest, et al. 2009). The use of real-life examples of chemistry has also been seen to increase student engagement and learning (Grannas, et al. 2010).

***Recruitment of Students.*** One student in my research group was recruited in person. Other students were recruited by two e-mails with promises of free beer and a two-credit independent study. The first e-mail was sent through the department listserv and the second e-mail was sent through the chemistry co-ed fraternity e-mail list. The two e-mails yielded approximately equal numbers of volunteers. Word of mouth also introduced a few others who ultimately could not participate.

Nine chemistry majors (eight seniors and one junior) were accepted for the two-credit independent study researching beer by analytical chemistry. I had served as a teaching assistant for four of the nine seniors in their junior year. The associate chair of the department accepted the administrative responsibility for the independent study as graduate students cannot administer courses.

This recruitment process is distinct from both required coursework and the traditional research experience. In most coursework, students have little freedom to choose a project. In most traditional research experiences, the student must actively seek out opportunities among unfamiliar research groups. During the projects, many of the students had questions that illustrated their confusion about the nature of academic research. They asked me about what I do as a graduate student: how much time I spend at work, how much guidance I receive from my advisor, etc. And they asked me about the department makeup: whether each professor has a research group, how research groups are different, etc. In general, I found that it would have been very difficult for most students to know what kind of research they were signing up for in a research group. Once they start to understand the workings of a department and the sub-disciplines of chemistry, it is often too late for them to participate in a research opportunity.

In contrast, this project offered a much more accessible starting point than some other active research groups. Students are interested in beer and have enough experience and common knowledge to come up with interesting hypotheses. Most of the students responded that beer was one of the main reasons that they volunteered for the project. (Q: "What made you sign up for this project?" A: "Beer.") Many of the students also said that they thought the project sounded "fun," which may have been related to the idea of researching beer.

Recruitment is actually an important issue with traditional undergraduate research models. Two of the four most common reasons that STEM

undergraduates give for not participating in research are “I was not aware that research opportunities were available to me” (28% of students who did no research) and “It never occurred to me to do research” (19%) (SRI International). Actively seeking out students using a topic of broad interest addressed this issue. The result was that seven of the nine students in the project had no previous research experience and only one student had previous research experience within the chemistry department.

**Demographics of the Students.** Chemistry is such a central science that it draws in students from around the university. Of the nine students in the project, two were double majors (Anthropology and English); one was planning to head to medical school; two were planning on applying to law school in the future; one was taking a research position and planned to attend chemistry graduate school; another was planning to attend graduate school in another health-related field, and the rest fell into an extremely diverse set of interests.

At first, this can be disorienting for an instructor who sees the primary benefit of research as being a building block for future research. Faculty members often see the students as future research scientists, although relatively few undergraduate chemistry majors will be long-term researchers. Students, however, have a much more flexible view of the benefits of practicing research. A 2006 study showed that faculty saw undergraduate research as part of professional socialization into the sciences, while students emphasized their personal and intellectual development (Hunter). I saw this in my group. While I looked at what they did as an opportunity to prepare for future experiences within academic STEM work, the students saw the experience as valuable regardless of the future application. The student planning to attend medical school commented that this may be the only research that he ever does but that he can envision the experience being very valuable in his future field. He improved his planning and time management and those were just as valuable to him as his practice designing and executing an experiment.

**Group Work Design.** A unique feature of this project compared to traditional undergraduate research experiences is that it was designed as a team project to last just one semester. The division of work between team members addresses the most common reason given for not doing undergraduate research: a lack of time (37% of non-researchers) (SRI International). Students in this project reported that they spent an average of four hours per week on the project. This average, however, was distributed uniquely between the team members. For example, Team 1 had five group members. There was rarely a need for five students to work simultaneously. However, the multiplicity of students was essential to accommodating busy students. For example, just in Team 1, one student had to leave the country suddenly, while another was often traveling for long weekends and another was completely unavailable for weekends. Then when some students had stressful assignments for other classes, other students could step in to do work. So teamwork is essential for addressing students’ busy lives and concerns about lack of time.

Students responded very positively to the group effort. One student commented: “I gained an understanding of how enjoyable it was to work on a project with other very motivated students. ... This project has ultimately changed my view on working in groups.” Another student confided in me that she has no friends in the chemistry major. After seeing the benefits of working together, she wishes that she had this support when she was in earlier courses.

**One-Semester Commitment.** The length of the project commitment was only one semester, which also addressed students’ lack of time on another level. The average amount of time that undergraduate STEM students who did research spent involved in research was 11.8 months (SRI International). Despite the short length of this project (13 weeks), students completed many of the key components of longer research projects. Several of the students who participated remarked that they were initially interested in the project because they felt that

research was something they “should” do before graduating with a chemistry degree. Proactively seeking out students for short, accessible research projects is a serious need. Without this project, the seven students who had not previously completed research would graduate with little or no exposure to academic research.

**Collaborative Nature of the Research.** The team effort was scientifically necessary. A real research project is much more time-consuming, with many logistical issues and data analysis to confront. In many ways, this is a more realistic view of science. Most research requires collaboration and all research builds on the work of others. The students grasped this value immediately. I did not officially appoint leaders of the groups, but eventually one person arose in each group to handle specific aspects of the project. One person would be the literature expert, while another would understand how to run the instrument, and so on. This seems to have worked well, but not always most efficiently. Some students responded that they would have preferred a little more structure on how to divide tasks. Another student who had taken leadership with logistical tasks was frustrated when his e-mails were ignored. But these struggles also taught the students. One student wrote: “More than anything else, communication among group members is key to the success of a collaborative project. This is an area where I think our group had the most to improve upon.”

The students not only learned to collaborate with each other, but also with several professors and staff who kindly offered their time. One student commented: “The most significant lesson I took away from this project was an appreciation for the collaborative nature of University research.”

## **ANALYTICAL CHEMISTRY PROJECT SUMMARY**

**The Student Project Outlines.** Team 1 had five students who proposed to identify and track the volatile compounds in the headspace above “Flower Power” brand beer throughout the brewing process. These compounds from the

yeast and hops are essential for the aroma of the beer. Tracking these compounds throughout the brewing process has direct implications on Ithaca Beer Company’s brewing process.

Team 2 had four students who proposed to identify the carbohydrates before (“wort”) and after fermentation (“beer”) in “Green Trail”, “Apricot Wheat”, and “Flower Power” beers. Studying the carbohydrates of the wort vs. the beer gives a clear picture of which carbohydrates the yeast metabolizes. Characterizing the yeast’s activity can help explain the unique tastes of Ithaca Beer.

**Student Project Timeline.** Students reported spending about four total hours per week, which is an ideal amount for a part of a 3-credit lab course that averages about 12-15 hours per week. Student work fell into the four phases seen in the timeline above. Work was collected for the literature review, experiment design, poster presentation, reflection paper, and final presentation.

**Project Budget.** Of the project budget of \$2,000, about \$1,445 was spent. Sixty-three percent of the spent money was on lab supplies and chemicals that can be used for multiple related experiments. The remainder was mostly instrument time paid to the NMR Facility at Cornell.

**Student Project Results.** Team 1’s results: From the beginning, Team 1’s project and method were well-defined and demonstrated in the literature. They successfully collected the volatile profile of each of the 10 days of fermentation of “Flower Power” beer. Ten important aroma compounds were identified and their relative abundance was tracked and attributed to stages of yeast metabolism and the addition of hops. The data were presented to the Ithaca Beer Company to give feedback on the length of fermentation and the addition of hops during fermentation (“dry hopping”).

Team 2’s results: Carbohydrates are fundamentally difficult compounds to study for analytical chemists, because they can be difficult to differentiate and can only be detected with certain

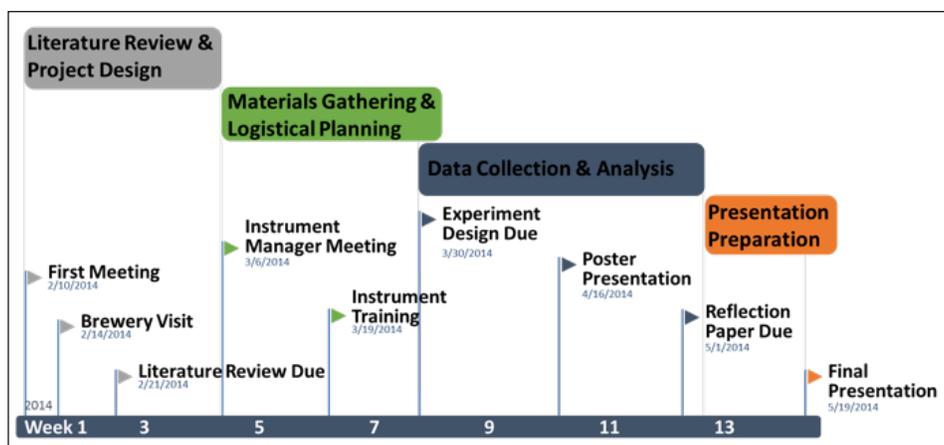


Figure 2. Student project timeline

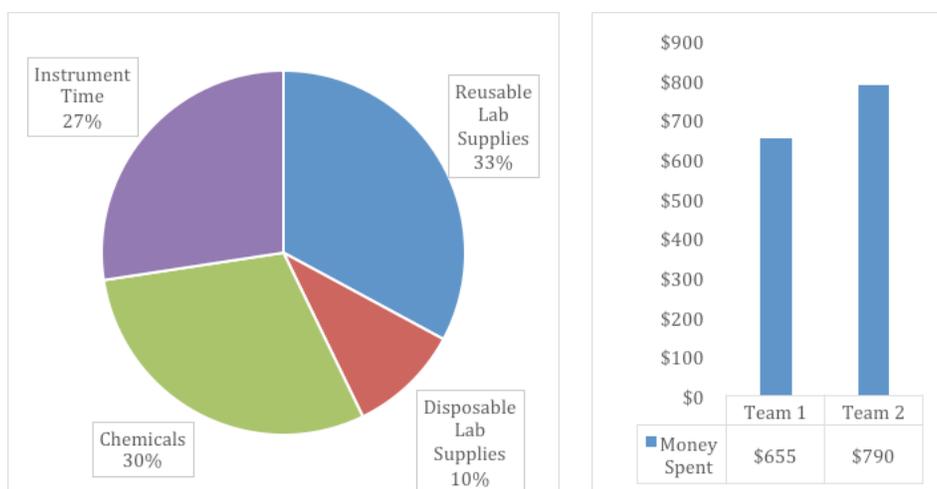


Figure 3. Breakdown of the \$1,445 project budget by purchase type and team.

methods. Consequently, the students developed methods for three instruments and demonstrated the methods on three sets of wort and beer. Two of these methods were able to successfully quantify six unique carbohydrates in wort and beer. These results were presented to the Ithaca Beer Company to illustrate the effect of using different worts and yeast strains. The team also identified one of the methods as their preference for future work.

**Response from the Brewery.** Students made a formal PowerPoint presentation to the brewers. The brewery appreciated the data and is hopeful that we can provide further results. The key to making the data useful for the brewery is increasing communication between the brewery and the project teams.

## PEDAGOGICAL EFFECTIVENESS

Students reported a number of science skills that demonstrate the effectiveness of this research project. They also came away with many other personal and intellectual skills that are not usually assessed.

**Reading Primary Literature.** After the teams defined their scientific goals, I provided the students with several examples of papers on related research. Each team did their own searching and found many more papers that helped with experimental design. One student wrote that, "Although reading journal articles is slow, I have found that the result is not only a better understanding of the subject matter, but also a better understanding of how science works." Most of the students told me that they had only

read scientific journal articles that teachers had assigned in class. They had not had any experience finding new articles and distinguishing useful and irrelevant articles. These are essential research skills for any scientist.

**Independent Science.** Students really enjoyed the independence. This was really the first time that they had had a project that they could control themselves and look at the result as completely their own. Reflecting on their results and presentations, several students said that they had accomplished something they were “proud of.” One student reflected on the project by writing, “Coming out of the chemistry major, there is little we can put on our CV/resume that says we are capable of independent scientific pursuit[...] This project, however, allows us free reign to demonstrate just that.” This result can be seen as professional development. Throughout undergraduate, graduate, and postdoctoral studies, chemists should increase their independence. Open-ended research-based labs are an effective way to increase student confidence and independence.

**The Wonder of Chemistry.** Students were extremely motivated by the visit to the brewery and the concept of studying beer. They were proud to share with their friends about how they were studying beer. They really appreciated being able to connect their chemistry knowledge with their everyday life. One student summed this up by writing: “This project reminded me of the childish wonders of the chemistry of materials and foods that got me interested in chemistry in the first place. I think this sense of appreciation and chemical interest of even common items is important to keep chemistry students grounded in the applicability of their field of study.”

**Complex, Real-World Data.** Students were really surprised by the amount of data analysis necessary. Near the end of the project, one student expressed frustration: “The process of actually analyzing the data is cumbersome and we are still hung up on simply identifying compounds rather than quantifying.” Another student commented that she was really surprised when she

got to use some of her data analysis skills from other courses. She was proud that she could put those skills to use.

**Planning a Research Project.** The students had a lot to say about the experimental design. Team 2 had much more difficulty finding a method to use. The struggles led them to appreciate this part of the project more deeply. One student wrote, “This was the hardest part, narrowing down the many options to the one research project.” Team 1 had a much more straightforward scientific project. But they still learned a lot about designing their own experiment. One member wrote: “the whole project has given me a sense of the time frame that a researcher must consider.”

**The Value of the Project to the Department.** The students were very enthusiastic about the project continuing. One student went so far as to suggest it as an entirely new lab class: “I would have loved to have a project like this at the end of one of the lab classes, or as an additional lab class after the completion of the first three.”

**Feedback.** Students did respond to the open-endedness with some hesitation. I found similar results to previous literature (Weaver). The higher-performing students were more disrupted by the freedom. The lower-performing students thrived under the new circumstances.

## CONCLUSION

**Pedagogical Success.** Most of the pedagogical goals of this project were met with remarkable success. Students independently studied primary literature and designed and executed complex experiments, leading to increased understanding of the nature of science. Students savored the experience of taking responsibility for an independent project with real-world implications.

**Logistical Adjustments.** A series of three or more lectures could address some lack of technical learning about brewing (could be covered

in one lecture) and the analytical techniques used (two lectures). Group work should be facilitated with weekly group meetings. More organized meetings are expected to be easier within a course with a scheduled meeting time.

**Departmental Concerns.** The project was indeed complex and time-intensive, but these factors made the project more of a learning experience. No faculty time was used in the project. Instrument training was given by facility staff, whose job description includes training. The project will be presented to the lab instructor with the hope of integrating research-based learning into the chemistry major curriculum within a lab course or as a sustainable elective.

## ACKNOWLEDGEMENTS

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# Learning Spatial Visualization: Beyond Drills and into Early Mastery

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## INTRODUCTION

In the College of Engineering at Cornell University, the goal of the Office of Diversity Programs in Engineering (DPE) is to support students, especially those with backgrounds traditionally underrepresented in engineering, and to provide the programming necessary to assist them in being successful. Consequently, we created a new spatial visualization course, entitled Spatial Visualization/Thinking for Engineers. This course was one of three interventions outlined in a grant awarded by the National Science Foundation (NSF) and the Science, Technology, Engineering, and Mathematics Talent Expansion Program (STEP).

During our course preparation and development, we noticed that the range of definitions for “spatial visualization” (SV) is wide and varied. Perhaps the simplest definition is “the ability to mentally manipulate, rotate, twist, or invert pictorially presented stimuli.” [1] Others define it as “the ability to manipulate complex spatial information when several stages are needed to produce the correct solution.” [2] The first definition represents spatial visualization as a kind of mental exercise; the second as a response to a particular problem or project. Other schools of thought refer to “spatial ability” or

“representing, transforming, generating and recalling symbolic, nonlinguistic information” [3], and that relation to “spatial thinking” or “a constructive amalgam of three elements: concepts of space, tools of representation and processes of reasoning” [4]. These different terms are often used interchangeably.

For the purposes of this paper, our team defines SV skills more generally as spatial intelligence, a term that contains for us the ideas of spatial visualization and spatial perception, including the activities of mental rotation of objects, spatial relation between objects, and overall spatial orientation [5]. As with mastery of any set of complex skills, doing one type of activity repeatedly does not develop that mastery; instead, a variety of sub-tasks or related tasks will move practitioners toward mastery [5].

Three groupings of research have emerged regarding the development of SV skills in students. First, some studies record group differences, often related to gender; these studies document findings related to particular kinds of SV skills, e.g., 3-D mental rotations. The strongest explanation for these differences is dissimilar socialization processes [3, 4, 5]. Second,

other findings report that it is possible to reduce or even eliminate these differences through direct instruction [6, 7, 8, 9]. Third, reducing or eliminating these differences or simply enhancing SV skills generally seems to be predictive of student success, typically defined as retention in the STEM fields [6, 8, 10, 11]. There is an important caveat related to the third of these understandings. We did not find in the literature empirical evidence or investigations that describe how students actually use or apply their newly-won SV skills in authentic engineering projects or to solve real engineering problems. While there may be some suggestive correlations that SV skills vary according to socialization, and that these variances can be reduced or eliminated, there is little if any evidence of what that “success” actually entails other than retention at the academic organization.

It was with all three of these understandings and this final important caveat in mind that the Engineering Communications Program (ECP), DPE, the Cornell University Engineering Success (CUES) program, and two Ph.D. graduate students from Biomedical Engineering designed and implemented an innovative active-learning, project-based course to teach Under Represented Minority (URM) and First Generation at College (FGC) students SV skills. Along with improving their SV skills, we were equally (actually more) interested in developing their spatial intelligence as applied to authentic engineering projects.

## **COURSE DESCRIPTION AND RESEARCH METHODOLOGIES**

The cohort of students involved in this first iteration of our SV course were pre-registered based on their invitation to and voluntary enrollment in the Robert L. Ryan Scholars Program (first-year students who have demonstrated potential despite a variety of educational risk factors). These factors include low resourced high school, low socioeconomic status (SES), FGC student, English as a second language, single parent household, and limited access to rigorous advanced placement math and science coursework. In the fall semester, all of the Ryan

Scholars (31 students) were pre-registered for the spatial visualization course regardless of their score on the Purdue Spatial Visualization Test (PSVT).

Our SV course was taught weekly for 14 weeks in the fall semester of 2013 at Cornell University. Following the NSF ENGAGE curriculum [13], the first six lectures instilled SV skills, including rotations, reflections, flat-patterns, cutting planes, combining objects, and isometric/orthographic sketching. We used the PSVT to conduct pre- and post-testing of spatial visualization tasks. The pre-test was administered prior to the beginning of the course; the post-test was administered in week 6. Then, the course’s second phase consisted of team projects, each with a client from Cornell biomedical engineering faculty. Instructors had worked prior to the course with those faculty to frame a visualization request that would extend students’ SV skills using the faculty’s own cutting-edge engineering research data. These projects were to challenge the students’ ability to understand, manipulate, and communicate complex SV concepts by requiring them to create clear and accurate visuals. Final deliverables to faculty included formal team presentations where they were evaluated by their peers, the instructors, and the faculty clients.

As we developed the course, we became very aware of how the term project-based learning (PjBL) was typically used and that it held a decidedly different meaning than problem-based learning (PBL), which often includes project-based learning within its framework. Both are, like spatial intelligence, complex: they provide a focus for intellectual inquiry; they eschew a tidy problem statement or any predetermined outcome; they encourage application of knowledge rather than rote learning; they rely on student action and critical thinking; functioning in teams; they encourage hands-on work; and they facilitate learning guided by faculty serving as mentors or guides [14-22].

From the start, we deployed PjBL purposefully, incorporating faculty clients who provided the projects for student teams. Our reasoning and

research led us to believe that having a concrete deliverable was a powerful tool for student engagement at a deep learning level. As such, we purposefully included client meetings and assessment as 2.5% and 5% of the final grade, respectively. We understood well that, while PBL may have some expected or predictable outcomes, PjBLs have no such comforts. Client interaction can bring new and fresh constraints, freedoms, or regulating factors on a team's project. The instructor often will not be able to anticipate a client simply saying "I don't like this team's approach at all," or "Can you do this all again, but this time aim for an audience of 8th graders?" In a sense, the instructors deploying PjBL have to be as agile (or more so) than the student teams working with the client. As PjBL work often does not have a pre-determined outcome or deliverable, clients can (and did) frame the deliverable with their teams variously. Projects were contingent on the client's specific need, and the projects were "real" and "authentic" because the deliverables/artifacts were going to be put into immediate use for biomedical engineering research purposes, in our case. The deliverables were to be a technical report (for academic assessment), a formal presentation where all clients and other stakeholders were present (assessed by clients and instructors alike), and the delivery of the client's requested artifact (poster, demo model, visual, etc.). The artifact needed to meet the specific stated needs of the client (which may differ from the expectations of the instructors) while also meeting the requirements of the academic unit.

We believed that this project-based course design would not only teach students SV skills, but empower them to apply these skills in real engineering contexts, thus enhancing and deepening their knowledge of spatial visualization. Furthermore, we believed that such early application of spatial visualization skills would provide relevant practice for engineering students for future school and engineering work. In addition, immediate examination of the process of applying spatial visualization skills to engineering project work would enable us to understand if and how SV skills specifically and

spatial intelligence more generally enhances success in engineering.

In order to study students' development or what "success" might actually entail, we employed two research methodologies. The first was an action research methodology, intentionally creating a new course design that went beyond drill-and-demonstrate. We wanted to deploy active-learning with a project-based pedagogy. We adhered to the standard approach for such action research, i.e., plan, act, observe, and reflect, collecting both quantitative and qualitative data. Inputs included PSVT pre- and post-test results, in-class instructor observations, journals, expert feedback on project results, student progress reports, project evaluations, and e-portfolios. We then used our second research methodology, "grounded theory," to code and analyze the data. Combining these two methodologies enabled us to track and learn about students' acquisition of SV skills, the development of spatial intelligence, their application of those skills, and their ability to critically evaluate their own and others' use of spatial intelligence.

## RESULTS

***Students showed enhanced spatial visualization knowledge after ENGAGE lectures.*** As noted above, the PSVT was twice administered. Students showed overall improvement after attending the prescribed six one-hour lectures. The mean score increased by 13% in the post-test as compared to the pre-test mean score of 75% (student's t-test,  $p < 0.05$ ). Furthermore, the spread in scores decreased, from a range of 35-100% on the pre-test to a range of 53-100% on the post-test, with 26 out of 31 students scoring higher on the post-test than the pre-test, two students with no change, and three students with a 1-question reduction in score.

***Phase 1 of SV Project-Based Learning: Bridging the gap between SV skills and the engineering project.*** In partnership with Cornell Biomedical Engineering faculty, the graduate student instructors designed four eight-week projects that would deploy student SV skills in a mean-

ingful engineering context. Each faculty “client” provided a set of images and/or data from his or her laboratory’s research where a visualization was needed. Clients framed the basics: the information to be communicated via the visual, the target audience, and the nature of the final product (2-D, 3-D, animated, or unspecified). Here, we will present one client project, “Nuclear Squeeze,” to show the stages of student team work.

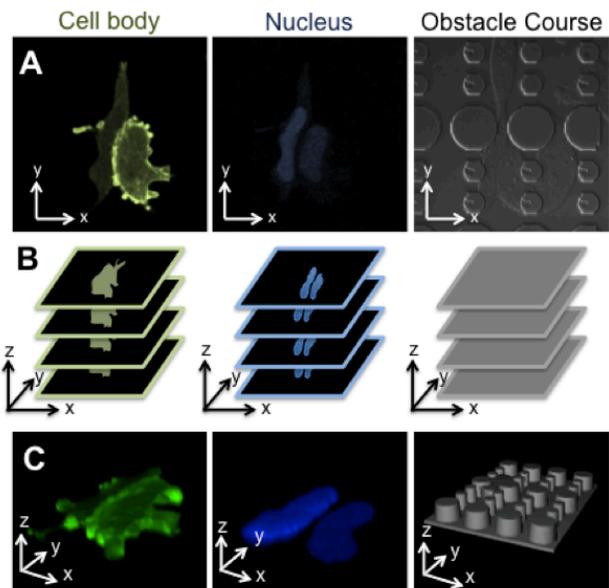
“Nuclear Squeeze” was completed for Dr. Jan Lammerding, whose lab studies the mechanical properties of cell nuclei and how those properties are modified in diseased cells. The Lammerding lab uses high-resolution confocal microscopy, a custom-nanofabricated cellular-level “obstacle course,” and fluorescently labeled cells to take images of single cells passing through a constriction, which allows them to observe and quantify the forces that cause a cell’s nucleus to deform. Dr. Lammerding requested a visual of the three-dimensional cell moving and changing shape over time, as it progressed through the obstacle course. The visual must explain to a layperson the movement of the cell and to answer one question, “Does the cell’s nucleus change in volume as it moves through the obstacle course?”

Nuclear Squeeze project teams were given a set of two-dimensional, multi-channel confocal microscopy images of the cell in the obstacle course with three distinct components: images of the cell body (green), images of the cell nucleus (blue), and images of the obstacle course (gray) (Figure 1A). The images were taken in “stacks” that could be compiled to create a 3-D picture of the cell (Figure 1B). These stacks were collected at regular intervals to create a full data set describing the 3-D cell’s movement in time (Figure 1C).

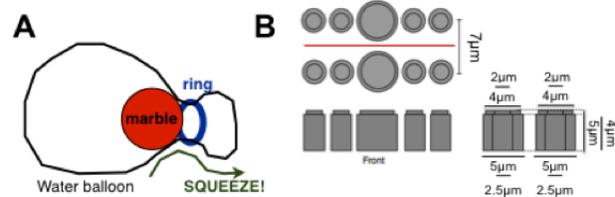
To facilitate cognitive connections between lectures and the client project, instructors created a worksheet for each project that connected students’ SV skills to the client requests (see Figure 2). These activities connected the SV skills learned in the course to the Nuclear Squeeze project, initiating students’ application

of spatial intelligence/reasoning.

An early launch in the fifth week of the course included teams receiving their client’s request and preparing for an initial client meeting. Teams created lists of three clarifying and/or extending questions for clients. During this client meeting, students and clients alike gained their footing:



**Figure 1.** SV Project “Nuclear Squeeze” data from faculty client. **A.** “Top-view” confocal microscopy images were taken of cells moving through a nano-fabricated obstacle course (green: cell body, blue: cell nucleus, gray: obstacle course). **B.** Sets of images had to be compiled by students into vertical “stacks” of 2-D images that could be rendered into 3-D by using image analysis software. **C.** These are 3-D renderings of image stacks, visualizing cell body, cell nucleus, and obstacle course.

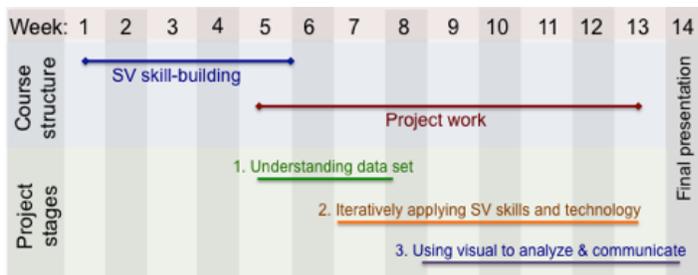


**Figure 2.** Partial worksheet for the Nuclear Squeeze project, designed by instructors to bridge the gap between SV lectures and projects. **A.** Analogy of cell moving through an obstacle course to a water balloon with a marble inside being passed through a ring. **B.** Orthographic projections of the “obstacle course” used by the Lammerding lab to apply forces to cells. Students had to create isometric drawings of the system and identify axes of symmetry.

- Student: *What do you think you could get out of looking at this in 3D?*
- Client: *Let me turn that back to you...Do you gain much by looking at this data in 3-D? Or do you not really gain much by doing this in 3-D versus using the best plane in 2-D?*

Such interactions reveal the hesitancy of students to claim SV proficiencies. Still, they lacked the confidence to deploy their SV skills in a real-world context. Thus, clients played an important role in maintaining the status of the students as SV consultants, by encouraging the students to act as SV experts.

**2.3 Phase 2 of SV Project-Based Learning: Students iteratively apply SV knowledge to complete project tasks.** Student teams progressed through three general stages of project work (Figure 3), as documented inside their e-portfolios and teacher interactions. First, students strove to understand the data set given to them by their client. Second, students iteratively applied SV skills and technology to develop an appropriate visual. Third, students revealed



**Figure 3.** Skill-building and project-based structure of the course over 14 weeks of instruction (upper). Project work proceeded in three overlapping stages (lower).

that visual to their clients and others.

In Stage One, students attempted to grasp the client’s data and to create a thorough understanding of the problem at hand. This stage was characterized by student e-portfolio entries such as these:

- *[ I ] was unfamiliar with the structure of a cell, so I researched info online.*
- *By attending the client meeting, now I know what the main goal of the project is, as well as a more concrete idea of what to do.*

StageTwo could happen only once they understood the context of their data set. Then, they iteratively applied SV skills to begin creating visuals. The instructors encouraged and mentored the use of technology, including MATLAB®, ImageJ®, SolidWorks®, and PowerPoint®. Students then connected SV lecture content to real-world applications. For example, students described challenges they overcame in using SV within the image processing software, ImageJ:

- *Had problems with orthogontal [sic] views in ImageJ. Solved it by changing resolution of image.*
- *Played with imageJ and figured out how to do an animated 3d gif. Also made orthographic images of our data. [sic]*

Armed with their developing language and skills, students easily manipulated SV technologies to create 3-D models, 2-D representations, cutting planes, and isometric views of the concepts integral to their client’s project. For instance, it was only after the Nuclear Squeeze team had created an isometric view of the images that students began to truly understand the challenge of quantifying a 3-D quantity such as volume from a set of 2-D images. Such understanding arose from the authentic SV interaction.

In Stage Three, analysis and communication, students cycled between visual creation, visual analysis, and visual communication, with clarity as the goal. For example, the Nuclear Squeeze students created a beautiful isometric 3-D rendering of the cell moving through the

obstacle course over time. However, they found that the isometric view of the whole cell was not sufficient in answering their client’s question: “Does the nucleus change in volume over time?” The team revised the visual to answer the question, eventually deciding to employ multiple orthographic views. They wrote,

- *[We] calculated an estimated volume of cell based on pixel area of **top and side view pictures...** Figuring out how to find **pixel area of irregular shape in Photoshop.** Found*

out through online researching” (emphasis added).

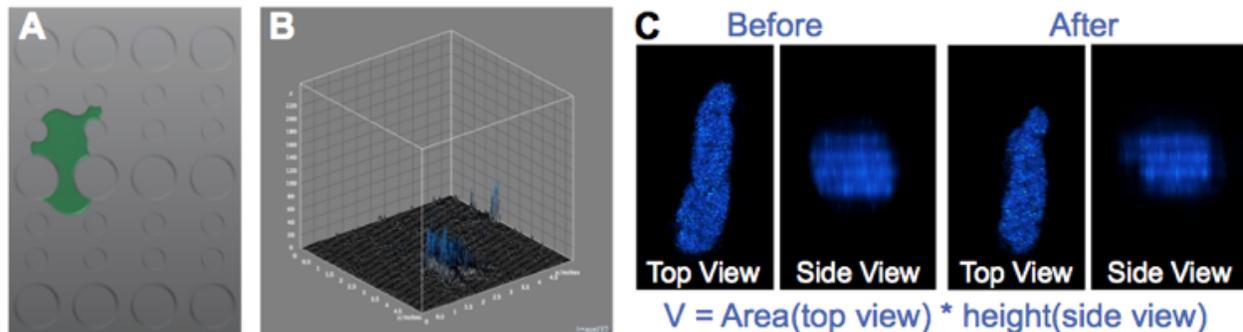
Finally, this group used a subset of their different visuals to communicate details of the data set, their approach, and their conclusion. Students made a 3-D CAD of the cell within the obstacle course to facilitate their own understanding and to print a hand-held replica of the obstacle course for their final presentation (Figure 4A). They also used multiple image-rendering functionalities within ImageJ to visualize and assess the data set, including a surface plot of the cell’s shape (Figure 4B). Furthermore, the students presented the orthographic views (top and side) of the cell at different time points of its migration through the obstacle course to communicate to their audience how they calculated change in nuclear volume (Figure C).

**Phase 3 of SV Project-Based Learning: Students act as SV experts, examining and critiquing use of SV in the final projects.** Throughout the proj-

will be viable throughout all stages of the project. The way to solve this is to keep experimenting.

Their demonstrated insight into the effectiveness of different visualization strategies points to translation of SV skills learned in lecture to the ability to create, interpret, assess, evaluate, and improve visuals of their own creation in real-world engineering contexts.

The course culminated with a formal presentation for peers, instructors, and faculty clients. At the same time, students evaluated their peers’ projects, specifically for SV prowess (Figure 5). Students identified use of simulations” as praise-worthy SV, indicating that the videos or animations used by their peers facilitated understanding. Students also praised “scaling” to zoom in or out on a feature and the use of vectors to indicate direction, among others. The ability of students to not only use, but to identify and critique the use of these complex strat-



**Figure 4.** Visuals created by students working on the Nuclear Squeeze project. **A.** CAD drawings of the cell (green) within the obstacle course (gray). **B.** Surface plot of the cell nucleus (blue). **C.** Orthographic projections of the cell nucleus viewed from the top and side, with volume calculations.

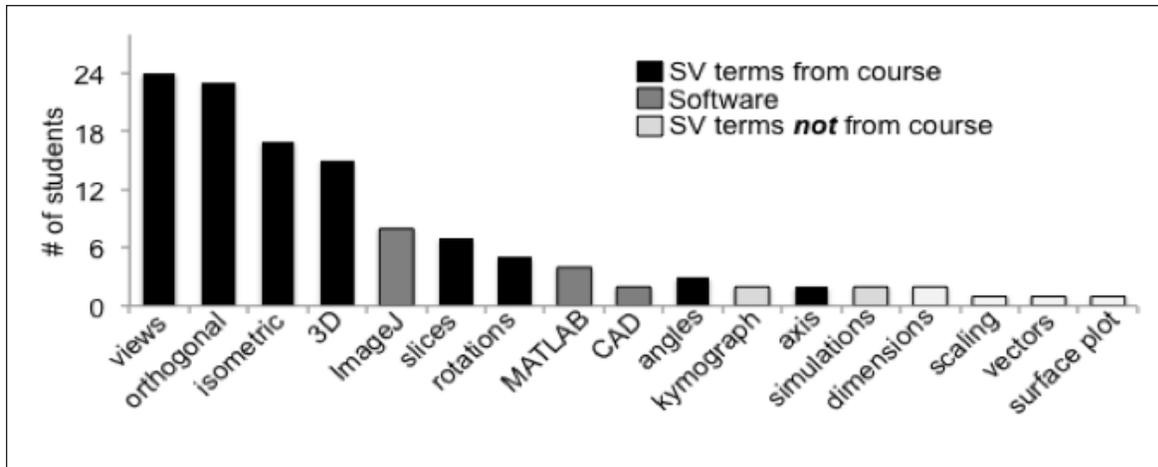
ect, students were able to use their mastery of SV to critically evaluate their own use of visuals in representing and evaluating an engineering concept, documenting progress in e-portfolios:

- *Tried to observe a change in the nucleus by overlaying 3 channels of images, but realized it was too cluttered.*
- *[The challenge is] deciding which software would be best suited to our desired task and whether our approach to using the software*

gies in others, is evidence of their ability to deploy SV skills successfully and act as subject matter experts in the use of SV in real-world engineering contexts.

## DISCUSSION AND CONCLUSIONS

This spatial visualization course went beyond drill-and-demonstrate methods. Faced with complex research-based data sets, they deployed knowledge of SV to understand the data, examine it, manipulate it and communicate it.



**Figure 5.** Frequency of student use of different terms in peer evaluation of SV projects. Note the range of terms not specifically taught but gained

Students not only gained basic spatial skills, but they were then able to use those skills successfully and authentically. Unlike many first-year courses, this course did not simply assume students were novices, but instead afforded them with an opportunity to become early experts.

Faculty clients were at the core of the course’s success, critically examining and assessing students’ ability. An innovation in this course is the direct interaction between first-year students and with high-level engineering researchers (all too rare). This course enabled and encouraged first-year students to work directly with faculty and the community of practice. Faculty provided feedback throughout the course and students gained confidence in their ability to understand and in turn, engage in intellectual dialogues about current research projects. As a result, students were exposed to engineering beyond the usual first-year mathematics and science courses, and this exposure deepened their interest in engineering, as students sought to learn more and communicated frequently with their faculty clients.

Using e-portfolios, students were encouraged to self-reflect on their progress and challenges throughout the duration of the course. This generative knowledge began to build a mastery of spatial techniques, thus enhancing spatial intelligence. Indeed we might argue that in a

preliminary way the above results represent important empirical evidence concerning what spatial intelligence actually involves. Through the acquisition of generative knowledge, students were not only able to understand the data presented to them, but were able to manipulate it, synthesize information and critically examine their use of learned skills in communicating the data. E-portfolio provided instructors with a direct lens to not only examine student progress and challenges, but to also understand the process by which students acquired generative knowledge in the course.

Unlike typical first-year classes, this course empowered spatial mastery through the use of several innovative methods. First, this course went beyond the usual drill-and-demonstrate method by implementing the application of visual skills in current engineering projects. Furthermore, students were not only assumed to be proficient at SV, but they were treated as experienced consultants in their interactions with current engineering faculty clients. Engagement with faculty in discussions about current research built student confidence and deepened the knowledge of engineering and its applications. Throughout the course, students were also able to acquire generative knowledge through self-reflection and the use of e-portfolios, further building a mastery of spatial skills and enhanced spatial intelligence.

## ACKNOWLEDGEMENTS

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# Problem-based Learning in Undergraduate Histology: Implementation and Student Perceptions

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## **ABSTRACT**

Problem-based learning (PBL) helps students learn and develop critical thinking skills by solving complex, realistic problems. Problem-based learning is common in both medical and basic science courses. Few reports are available on the use of PBL in undergraduate histology, however, which is traditionally taught in a lecture-lab format. In the present study PBL was integrated into a senior-level undergraduate histology course in the form of case studies. Student perceptions and engagement were then evaluated. Two case studies were developed to complement the topics of respiratory tract and female reproductive system histology, which were previously taught by lecture and descriptive lab guide. Histological specimens were provided as digital slides, and post-lab surveys, classroom observations, and student work were used to evaluate the success of the case study assignments. The class rated the activities as enjoyable and useful in post-lab surveys. Students recognized the real-world applications of the cases and the value to their future as medical professionals and scientists. Classroom observations suggested that students were engaged with the cases and motivated to complete them. In addition, many students produced lab reports that included work well beyond what the assignment required, suggesting they were engaged with the case study topics. The PBL activities were well received and successful in this particular course and will likely continue to be a part of the curriculum in the future.

## **INTRODUCTION**

Histology is traditionally taught by a combination of didactic instruction and laboratory sessions in which students review glass slides with a microscope (Bloodgood and Ogilvie, 2006). While this is an efficient method to deliver course material, some students have reported low enthusiasm for the subject and difficulty understanding the importance of learning histology when these teacher-centered methods

are employed (Goldberg and Dintzis, 2007). Some believe that this teaching method limits student engagement and learning, particularly as student populations grow and diversify (Parton and Bailey, 2008).

Evolving approaches in histology instruction include two major ideas: the use of virtual specimens and moving towards student-centered

approach. Virtual microscopy is popular in many programs including the course described in this paper, as a means to make specimens more accessible to students (Nelson et al., 2012). Student-centered, active learning approaches such as peer instruction and team learning are becoming popular in histology courses as well (Goldberg and Dintzis, 2007; Bloodgood, 2012; Campos-Sanchez et al., 2012).

Problem based learning (PBL) is a method of student-centered pedagogy that could increase student engagement and learning in the histology classroom. Problem-based learning was formalized in medical curriculums in the 1950's and 1960's as response to the difficulty of teaching the ever growing body of medical knowledge and the desire to align teaching methods with clinical practice (Barrows and Tamblyn, 1980). In PBL, clinical or scientifically relevant problems drive student learning. Students are presented with meaningful, authentic problems, often in the form of case studies, for which they enter a student-centered inquiry process to solve. Participants must identify their knowledge gaps, locate information to fill them, and ultimately solve the problem. This is often done in groups and is facilitated by an instructor or tutor. PBL emphasizes skills such as problem solving, self-evaluation, and independent learning in addition to learning course material.

Problem-based learning has been used and evaluated in both the medical and basic sciences. Students generally favored PBL as compared to lecture-based teaching methods in medical programs (Bowe et al., 2009; Zimmermann, 2010). The clinically-relevant problems have helped medical students build confidence for future clinical situations and have promoted achievement in clinical knowledge, reasoning, and other non-cognitive behaviors (Hudson and Buckley, 2004; Distlehorst et al., 2005). Students who participated in PBL also had similar perceived and actual knowledge as students in traditional classrooms (Enarson and Cariaga-Lo, 2001; Prince et al., 2003). PBL has even been associated with higher assessment scores compared to traditional instructional methods in both medical and undergraduate courses (Cliff

and Wright, 1996; Jamkar et al., 2006; Zimmermann, 2010).

PBL has been employed in graduate-level histology courses, and reports on these experiences have given valuable information on development and teacher and student perceptions (Eurell et al., 1999; McBride and Prayson, 2008). In veterinary histology courses, students reported a greater understanding of the subject and felt their problem solving skills were improved with a case-based approach (Eurell et al., 1999). In veterinary pathology, a science that relies heavily on histology, PBL was associated with independent learning, critical evaluation, teamwork, and integration with information from other disciplines (Krockenberger et al., 2007). These reports suggest that PBL may be an effective approach to teaching undergraduate students histology that will be well received and promote learning. A careful evaluation of PBL in the undergraduate histology classroom is therefore warranted.

The purpose of this study was to evaluate student attitudes towards and engagement with PBL exercises in an undergraduate histology course that generally uses the lecture/slide examination format. Case study-based exercises were developed for two course topics to evaluate how students perceive and learn from PBL with student surveys, classroom observations, and student work.

## EXPERIMENTAL PROCEDURES

**Context.** This study was performed during the Spring 2014 semester at Cornell University in Ithaca, New York. The course was senior-level undergraduate histology offered by the Department of Biomedical Sciences at the College of Veterinary Medicine. The course covered histology of all of the major organ systems, using histological specimens from several vertebrate species. It was a four credit, full semester (14-week) course that met twice per week. Each session consisted of a 55-minute lecture followed by two hours of laboratory time. In the laboratory, the students were given a packet with detailed descriptions of the specimens to

be examined that day, corresponding to the lecture topic. Between four and seven specimens were examined each day. Specimens were scanned using the Leica ScanScope system to produce high resolution digital images, and students viewed these with the Aperio ImageScope software (Aperio Technologies, Vista, CA). The students also had access to glass slides corresponding to each specimen, which they were encouraged to use in order to practice their microscope skills. There were four graded lab assignments during the term which included short answer questions about the structure and function of particular specimens. Students were encouraged to work in pairs, but a few elected to work independently. There was one faculty member, one postdoctoral teaching assistant, one graduate teaching assistant, and three undergraduate teaching assistants available to the students, and this was my second time as a staff member of this course.

**Study Design.** Two separate case study assignments were developed to complement two existing course topics. Students were asked to complete each assignment and then fill out a post-lab survey. Survey responses, classroom observations and analysis of student work were used to evaluate the success of case studies in this course. All students in the course were invited to participate in the study after they were informed of the research goals and procedures. Individuals were given the opportunity to exclude themselves from any part of the study without penalty to their grade or standing in the course. The research methods used in this study were approved by the Institutional Review Board at Cornell University.

**Student Sample.** The class included 39 students (female = 19, male = 20). Mean student age, years of higher education, and approximate GPA are given in Table 1. Figure 1 illustrates the college majors and career goals of the participants. The majority of students were biological science or animal science majors aspiring to medical or research careers. Thirty-nine percent of students who responded to the post-lab surveys had done PBL activities before in previous

courses.

**Development and Implementation of Case Studies.** Two case studies, on the topics of respiratory tract histology and female reproductive system histology, were developed using materials published by the American College of Veterinary Pathologists (ACVP) (Sasseville et al., 2012; Sasseville et al., 2013). These resources included case histories, diagnoses, and links to high resolution scans of histological specimens available on the Aperio ImageScope server. Each case study assignment included the animal's case history and ten short-answer questions that served the learning outcomes previously established for the topic. The case studies were appended to the descriptive lab packet corresponding to the class topic. Students were asked to review the information and specimens in the descriptive packet and then attempt the case study assignment.

Case 1, on the topic of respiratory tract histology, was assigned during week 10 of the course. This was a case of pulmonary edema in a Rhesus Macaque. This case was offered to the students as a voluntary learning exercise, and it did not factor into the course grade. Students were not given the animal's diagnosis, but they were provided with the case history and histological specimen as a digital slide. The goal was for students to review the slide, identify the abnormalities, and explain how these abnormalities relate to their diagnosis. Students were given one week to complete this assignment. The teaching staff reviewed each assignment, and comments were returned to the students the next class period.

Case 2, on the topic of female reproductive system histology, was assigned during the final week of the semester. This was a case of an ovarian teratoma, also in a Rhesus Macaque. The diagnosis and case history were provided in the assignment, and students were asked to identify at least five abnormalities in the tissue and answer other related questions about the histology of the ovary and oviduct. The case

study was a class requirement, and students were given three days to complete it. Students were encouraged to use any sources they found appropriate to complete both Case 1 and 2. The classroom structure was not altered for the case studies, and students were given the freedom to work in pairs, small groups, or independently as they had done throughout the term. The six members of the teaching staff circulated within the laboratory to assist and check in with students as they worked on the case studies. The answers to each case study were made available to the class after the graded assignments were returned.

**Student Surveys.** Students completed an anonymous post-lab survey after each of the case study assignments, which was provided on paper the day the case study was distributed. The survey asked students to rate their motivation, engagement, and interest in the case study topics on a scale of 1 (lowest) to 4 (highest). Students rated how well they believed the case studies helped them learn and build skills valuable to their future careers. Open-ended questions asked students about what helped or hindered their motivation and what they did and did not like about the case studies. Surveys were collected anonymously at the time the case studies were collected for grading. Themes were identified in responses to open-ended questions. Any concept that was mentioned by at least two students was considered a theme.

**Classroom Observations.** During the class periods in which students worked on the case study assignments, I acted as a participant observer. I took detailed field notes on class and group dynamics and student comments and questions. I also made note of how students approached the problem in the assignment and the sources they used to answer the case study questions. Field notes were analyzed for themes as was done with open-ended survey responses.

**Analysis of Student Work.** Learning associated with Case 1 was assessed by an in-class quiz. The course final exam assessed learning associated with both Case 1 and 2. The questions per-

taining to respiratory and female reproductive system histology were included in the analysis. Because the first case study was optional and not completed by each member class, there was the opportunity to compare the exam scores of students who completed the activity to those who did not. The case study assignments that were handed in were also graded and analyzed for content.

**Statistical Analysis.** Results were analyzed with JMP Pro (version 9.0.2, SAS Institute, Cary, NC). Mean quiz and final exam scores pertaining to Case 1, Case 2, and all other course topics, as well as mean survey responses were analyzed by a Wilcoxon rank sum test. All data are reported as mean  $\pm$  standard deviation.

## RESULTS

**Student Surveys.** Thirteen students (33% of class) completed Case 1, the voluntary case study assignment on respiratory histology, and filled out the post-lab survey. Thirty-eight students completed the second, required case study assignment on female reproductive system histology. Twenty-eight students completed the corresponding post-lab survey (71.8% of class). The mean score for each of the close-ended questions corresponding to Case 1 and 2 are shown in Figure 2. Mean scores reflected positive opinions of the case studies ( $>2$  on scale of 1 = lowest to 4 = highest) for all survey questions. Scores did not differ between Case 1 and 2. Self-reported student demographics (e.g. GPA, age, gender) were not associated with any of the close-ended survey responses. There was also no effect of working independently or in a group on survey means. The themes drawn from the open-ended survey questions are shown in Table 2. Many students reported interest in the case study topics and enjoyed problem solving. Some students felt, however, that the course lecture did not adequately prepare them for the case studies. The skills students reported using to complete the case study activities are given in Table 3. The majority of students reported practicing the skills of problem solving, critical assessment of new information, and synthesizing new infor-

mation.

**Classroom Observations.** The lab portion of this course is held in a computer lab equipped with microscopes. Generally, students work in groups of two to three or independently to review either the digital or glass slides. The teaching staff circulates the room to check in with the groups and assist students with their questions. This structure was maintained during both of the case study activities.

**Case 1:** Most students did an initial review of the specimen before they attempted the case study questions. Many students did an internet search of the problem presented in the case. Many students used online images of pulmonary pathologies, Wikipedia articles, YouTube videos, or online textbooks to help them answer the case study questions. I did not see any student using peer-reviewed papers as a resource. One group of students appeared frustrated with the case study (tossed up paper and said, "I give up"), but elected not to speak with a member of the teaching staff for assistance. There was some evidence of distraction (spending time on Facebook, email, and other websites), but student comments suggested that many were engaged with the case. These included comments such as, "interesting" and "this tissue is so much different [than normal]."

**Case 2:** The classroom appeared to be livelier and students were interacting with each other and the teaching staff more than with Case 1 or any other lab that semester. Many students did an initial review of the slide before answering the questions as they did with Case 1, and they used similar sources as they did in Case 1. Some of the student comments about the specimen included, "awesomely disturbing"; "that is crazy"; and "I love it." The most common questions requested clarification on teratoma development. I did not notice any obvious signs of distraction during this class period as I did with Case 1.

### **Student Work.**

**Case 1:** Fourteen assignments were collected for grading, and 64% of the students correctly

diagnosed the pathology. The mean score on the assignments was 90.9% ( $\pm 10.0$ ,  $n = 14$ ). The mean score on respiratory histology quiz questions from students who completed the case was 95.6% ( $\pm 7.3$ ,  $n = 15$ ) and 96.4% ( $\pm 3.4$ ,  $n = 15$ ) for those who did not complete the case. The mean final exam score on respiratory histology questions was 84.3% ( $\pm 22.0$ ,  $n = 13$ ) for students who completed the case study and 83.2% ( $\pm 18.8$ ,  $n = 23$ ) for those who did not. There was no significant effect of having completed the case study on performance on either assessment.

**Case 2:** Thirty-eight assignments were collected for grading. A diverse body of work was produced. All of the students were able to identify the minimum number of abnormalities requested. Assignments ranged from those that answered the questions at a minimum (3 pages) to reports of up to 15 pages. The most extensive reports included additional diagrams and photos describing ovarian histology that were not requested in the instructions (18.4% of assignments), additional abnormalities beyond the minimum (50%), and literature citations (13.2%). The most common mistake made was neglecting to give a reason for the identification of a particular abnormality (9 students). Despite this, several students had found abnormalities that were not originally identified by the teaching staff (e.g. bone tissue in the ovarian teratoma). The mean score on these assignments was 94.8% ( $\pm 8.3$ ,  $n = 36$ ). The mean score on final exam questions relating to female reproductive system histology was 93.3% ( $\pm 7.1$ ,  $n = 36$ ). The mean score for all other course topics was 85.3% ( $\pm 0.1$ ,  $n = 36$ ). Students performed significantly better on the female reproductive system questions, which was taught by case study, as compared to all other course topics combined ( $p < 0.0001$ ). Because all students completed Case 2 it was not possible to determine if students who completed the case performed better on the exam than students who did not.

## **DISCUSSION**

Problem-based learning and case studies have been used to promote problem solving, critical thinking, and independent learning in basic and

applied sciences (Barrows and Tamblyn, 1980). Student interest in and engagement with the case study topics are key to the success of PBL. Reports on the use of case studies in histology are limited, particularly at the undergraduate level. The goals of this study were to introduce case studies into an undergraduate histology course and use student surveys, classroom observations, and student work to evaluate their success. Emphasis was put on how interesting students found the case study topics, their engagement and motivation with the cases, and what aspects they liked and disliked.

Many of the goals of problem-based learning were met with the use of case studies in this course. Overall, students reported in post-lab surveys that they were interested in the case study topics, engaged with the material, and were motivated to complete the assignments. These ratings did not significantly differ between two separate case studies, despite their different nature and the different number of students that attempted them. Feedback provided by open-ended survey questions made it clear that many students recognized that the case studies had clinical relevance and real-world applications. One student mentioned that she could see herself "actually having to solve these problems in [her] future profession." A majority of survey respondents felt that the activity was useful in preparing them for the future. This perceived utility is encouraging as a means to engage students in the course material, as the majority of these students were seeking careers in medical professions. Many students also mentioned that they enjoyed learning pathology and that this motivated them to complete the case study assignments. Other students mentioned that they liked applying concepts they had learned in this and other courses to the problem at hand. One student reported that the case was "a culmination of all we had learned." The classroom was interactive during both case study activities. The livelier classroom observed during Case 2 might be the result of a greater number of students working on the assignment, last day of the semester excitement, or greater interest in the topic com-

pared to Case 1 and/or the other lab activities.

Many students both recognized and enjoyed using the problem solving skills required by the case study assignments. Some students were bothered, however, by having to gather information from outside sources. These comments are not surprising because the descriptive lab packets and textbook generally provide the information required to complete all course assignments. One student mentioned that it would be helpful if they were provided with a list of potential sources of information. If case studies were to be implemented on a larger scale in this course it would be helpful to dedicate some class time to reviewing the skill of literature searches prior to starting the first case. One of the goals of PBL in this course was to help students become comfortable using this skill, and explicit teaching and practice will likely be required to meet this aim.

One third of the class completed the voluntary Case 1 assignment. This proportion may speak to the perceived usefulness or enjoyment of the exercise. However, completing Case 1 did not affect the score on the respiratory quiz or final exam questions. The answers to the Case 1 assignment were made available to all students prior to the each assessment, so that individuals who did not participate in this phase of the study were not at a disadvantage. This might explain why the scores were comparable. This is not the first study, however, to find that students who participate PBL activities perform equally as well as students participating in more traditional teaching methods on assessments (Enarson and Cariaga-Lo, 2001; Prince et al., 2003; Pourshanazari et al., 2013). Most importantly, these results indicate that students who spent the time to complete the case study activities were not less prepared for the class assessments than their peers.

The additional work produced by many students beyond what was required in Case 2 is evidence of student engagement with the assignment. It was clear that many students enjoyed discovering abnormalities in the specimen. Several students also used photographs

of the specimen to describe the histology of the normal ovary and oviduct in their assignments. This suggests that they found the specimen to be adequate for learning the normal histology of the female reproductive tract as well as the abnormal histology of the teratoma.

The case studies used in this study were relatively simple to develop with the online materials available from the ACVP. The detailed case histories could be edited and adapted for use by students in this course. It was easy for students to access the virtual slides from their computers both in and outside of the laboratory. The success of this system in this particular classroom highlights the usefulness of high quality digital histology specimens in educational settings. One student mentioned that he would have preferred a glass slide to the digital image which would have made it a more hands-on learning experience for him. It was not feasible to obtain the number of slides required for the course with these pilot case studies, but it would be a goal if case studies were to become a more significant part of this course in the future.

This study did not attempt to compare student opinions of the case studies to the standard lab activities in this course. This may be a worthwhile future investigation if case studies were to be used more often in this course, in order to estimate the success of case-studies in this particular course.

The case studies might be improved by implementing a more structured classroom environment. For example, the instructor could establish uniform group sizes and students could be given dedicated roles within their group. This strategy might allow more students to practice the skills of teamwork, communication, and time management, which were the lowest reported skills used to complete the case studies. Teamwork and communication may also be addressed by adding classroom discussions to the case study activities.

## CONCLUSIONS

This is, to my knowledge, the first report on

implementation and evaluation of PBL in an undergraduate histology classroom. Case studies were successful in this context, based on positive feedback in student surveys and achievement on case study assignments and other class assessments. Students were engaged with the PBL material and enjoyed the problem solving the case studies required. Based on these results, case studies will continue to be a part of the histology curriculum at Cornell.

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# The Goals and Motivations of International Students at an American University: Implications for Doctoral Mentorship Practices

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## Abstract

As the population of international students in North American universities grows rapidly, administrators and educators are faced with the task of figuring out how the academy will accommodate the changing student landscape. This is particularly true in the field of engineering and other technology-related fields. International students face many kinds of challenges in a new environment. Moreover, at the graduate level, faculty and international students may experience low productivity when their educational goals are misaligned. That these misalignments can be subtle and often unconscious to both parties can bring added frustration. The present study describes misalignments between the research and long-term career goals of educators and international students. I found differences in international students self-reports of motivations for research and faculty perceptions of international students being extrinsically motivated. Critically, I found that faculty members are often ignorant of how limitations of visa status duration influences doctoral student research. I will discuss how knowledge of these misalignments will better inform mentorship practices for international students in research-driven doctoral programs in North American universities.

## INTRODUCTION

A great deal of research has looked at factors influencing international students adjustment when studying abroad. Le and Gardner (2010) find that other than their international students status, Asian international doctoral students in the STEM fields face issues like lack of funding and limited resources. In addition, international students face some of the same issues as domestic students in science, engineering, and technology fields to a greater degree. For example, Giles et al. (2009) found that gender discrimination was experienced to a far greater degree by female international students. International students may also experience some

identity issues (Gomes et al., 2014). In addition to these, international students also experience feelings of social isolation from peers and faculty. This latter concern of social isolation has been greatly studied and students' preferences for sources of help might partly explain this. Leong and Sedlacek (1986) find that international students were more likely than U.S. students to prefer faculty members and counselors for help with educational and vocational as well as emotional and social problems. U.S. students were more likely to look to peers and friends. Zhang and Goodson (2011) find that among factors like language proficiency, gender, and

country of origin, social support was a strong predictor of successful psychosocial adjustment to life in the U.S. Wang (2009) finds that personality characteristics like resilience (high self-esteem and high beliefs in self-efficacy, the belief that one has value as a person, and that the world holds opportunities even in bad situations) all had strong negative correlations with adjustment problems.

International students make major contributions to the academic community they join. Academically, Su (2013) finds that the presence of international doctoral students in science and engineering departments actually increases graduation rates among domestic students. However, compared to their domestic counterparts, international students doctoral students in engineering and information technology disciplines have lower attrition rates, shorter completion times and also have more publications by the time they graduate (Yarlagadda et al., 2013). Chellaraj et al. (2008) found that international students positively increase both future patent applications and future patents awarded to university and non-university institutions. This high rate of success could be partially explained by the fact that, at least at the undergraduate level, international students are more engaged in educationally purposeful activities than American students (Zhao et al., 2005). The authors report that international students, more than American students, made more progress in general education and job-related skills, spent more time in collaborative learning situations and interacted more with faculty members. Nevertheless, international students reported lower satisfaction with their school experience and spent less time on relaxing and socializing than American students. At the level of faculty, international faculty members continue to be significantly more productive in research, but are less productive in teaching and service than U.S. citizen colleagues (Mamiseishvili and Rosser, 2010).

Socially, international students bring a sense of diversity and globalization to college campuses. Faculty members cite this as a major social contribution to U.S. universities (Trice, 2003). However, Montgomery (2009) finds that while domestic students report that cross-cultural interactions are valuable to them during group work, international students still experience ethnic reductionism on college campus. That is the

idea that all of one's behaviors may be explained by one's ethnicity.

The enrollment of international students has been an economic investment for the U.S. (See Hegarty, 2014, for an in-depth review). In 2012, international students contributed over 24.7 billion USD to the U.S. economy (United States Department of Commerce). Of the 819,644 international students enrolled in the 2012/2013 academic year, 64% use personal or family funds to pay for their studies, 21% are supported by their U.S. host institution, and only 1% of the students receive support from other U.S. sources (Institute of International Education). A major driving force for the increased enrollment is due to the increased recruitment of internationals by U.S. universities, primarily from South and East Asia (Institute of International Education). The Institute of International Education (2012) reports that a lack of funding to public universities has increased their reliance on the revenue provided by international students. However, this increased recruitment by schools and enrollment has not been paired with a proportional increase in the quota for H-1 visas in the U.S. The H-1 visa, requiring sponsorship from an employer, allows foreign nationals to work in the U.S. and is the next step for international students interested in staying in the U.S. Between 2007-2012, F1 visa issuances saw a 63% increase while H1B visa issuances only actually decreased by 12% (United States Department of State).

This is, of course, only an issue if most international students seek employment in the U.S. following graduation. Examinations of international students long-term career goals reveal that 75% of international students tested actually reported seeking permanent employment in the U.S. after graduation and 78% in a more recent study (Spencer-Rodgers, 2000; Musumba et al., 2011). The myth that international employment will decrease job opportunities to domestic students is dispelled in the 2013 study by Su and colleagues who find that international student enrollment rates have no effect on the rate of domestic doctoral students getting a job. In a Canadian population, international students

believe that working in the host country will lead to a better quality of life and career incentives (Nunes and Arthur, 2013). Additionally, decisions to stay are often influenced by familial connections. However, the same study found that half of the participants believe that their expectations for enhanced career opportunities in Canada were unmet. In the transition between school and work, international students struggle with building networks and employment contacts prior to graduation, and international students felt that companies discriminated against them due to their international status (Nunes and Arthur, 2013). The authors, however, do not report whether this discrimination is racial or due to lack of desire for companies to engage in visa sponsorship for international students.

Previous research on international students has looked at the early adjustment period as international students enter American universities and the transition between university and the workplace. The present research attempts to bring together these two literatures. We focus on how motivations for coming to the U.S. and long-term career goals affect international students research performance during their doctoral programs. In particular, we find that faculty perceptions of students' motivations for pursuing school in the U.S. and long-term career goals differ greatly from students' self-reports. In addition, faculty and international students differ in what they believe to be major hindrances to research success. I will describe how these misalignments lead to frustrations and challenges.

## METHODS

*Participants.* The participants were a group of six professors (five males and one female) and four graduate students (three males and one female) in the College of Engineering and Department of Psychology at a large research university in the northeastern United States (U.S.). The students and faculty members came from subfields within the department including, Mechanical and Aerospace Engineering (MAE), Biomedical Engineering (BME),

and Civil and Environmental Engineering (CEE). The faculty members varied in their teaching experience; most had taught longer than 10 years at an American university, one faculty member taught less than five. Most were American citizens, although two had immigrated from Europe and Australia. Two students came from China and two came from India, and had none had lived in the US prior to their studies. The two Chinese students began their doctoral studies in the U.S. immediately following their undergraduate studies in China. The two Indian students worked for two years in India prior to beginning their doctoral programs. They varied in age from 24-35. They were all presently or previously enrolled in a doctorate program in the College of Engineering at a large research university. The students varied in their doctoral progress from two years in to their final year before graduation.

All participants were selected from the author's professional network and recruited by e-mail or verbal conversation. Participants were not financially compensated for their participation.

*Materials and Procedures.* The present study includes semi-structured interviews as a means of data collection with participants that proceeded in two phases. In the first phase, I arranged an initial, 15-minute meeting with each participant to verbally discuss the study, answer any questions, and ensure the anonymity and privacy for the participants by reviewing a short informed consent script. Once consent was given, the second phase began. This phase included the interviews with the participants. All interviews lasted about one hour and were conducted in English. The interviews were loosely guided by a pre-generated list of questions, but the interviewer often responded to comments made by the participant that were relevant to the main research question. All interviews ended with the interviewer soliciting recommendations or advice regarding international students. The interviewers asked interviewees to advise their particular department, faculty members, incoming international students, domestic students, and their university as a whole about international students. The author had two purposes for these recommendations. First, the

recommendations gave room for students and faculty to give meaningful advice. Second, the author reasoned that asking interviewees to give anonymous advice would allow them to discuss dissatisfactions with their university and peers when they would have otherwise felt uncomfortable. A short discussion with participants following the interview served the purpose of a debriefing session and allowed participants to include any comments beyond the items discussed.

The interviews were audio-recorded using a hand-held recording device and transcribed later by the author. Ethical approval of this study was obtained from the Institutional Review Board at Cornell University.

*Data Analysis.* The main purpose of analysis was to characterize themes that emerged from the interviews. The first author re-read transcripts and re-listened to the interviews in full and noted major topics that came up. For example, the topic of “visa status” was discussed by all international students although participants differed in their thoughts about whether or not faculty should be involved in helping students obtain their desired visa status (Figure 1). The individual themes were then grouped into three broader categories: Observations, Practical Concerns, and Ideals/Beliefs. Observations included comments by international students and faculty on the demographic make-up of groups or observations of social interactions. Practical concerns included concerns whose influence was limited in duration and had discrete actions that led to outcomes. For example, the topic of “visa” is considered a practical concern because there are prescribed steps that one can take to obtain a visa or to extend one’s visa. Ideals/Beliefs refer to themes which were more intangible and often do not involve set prescriptive actions. These themes are more concerned with characteristics or traits of individuals or philosophical beliefs; for example, “intellectual freedom.”

I noted commonalities in the language used to describe participant experience and expectation.

Finally, categories and differing thoughts were explicitly compared between faculty responses and student responses with a focus on general trends within each group. I made these comparisons in terms of motivations for doing research in the U.S., major hindrances to doctoral program success, and finally long-term career goals. I characterized misalignments between faculty perceptions and student self-reports within these categories.

## RESULTS

*General Trends.* During interviews, faculty tend to use “international students” to refer primarily to “Asian” students – Chinese and Indian students, specifically, although many mentioned Korea as a primary origin as well. China, India, and South Korea are the top three originations of international students at the university where these faculty teach, so their general impression is consistent with the demographics of enrollment. Two faculty members named students from Puerto Rico as “international,” not in the sense of nationality, but rather in terms of cultural and primary language differences.

Faculty and international students make explicit distinctions between Indian and Chinese students. First, some faculty members who brought up language as a hindrance to progress in doctoral programs explicitly stated that it was more of an issue for East Asian students than for Indian students. Similarly, Indian students don’t report spoken language as a hindrance to research progress or interpersonal communication. These students tended not to mention cultural differences as a hindrance either. In fact, one student explicitly discussed the export of American culture to India and his familiarity with the cultural practice upon arrival to the U.S. Chinese students, however, tend to bring up spoken language as a barrier to interpersonal relationships with domestic peers. The barrier seems to be more so a lack of understanding of cultural referents in language. Additionally, the first author observed that the Chinese international students interviewed used language that betrayed feelings of being

restricted when speaking in English. That is, speaking in English did not allow them to properly self-disclose or fully express themselves.

Faculty perception of cliques. Another emergent theme is faculty's perception that certain international students groups form "cliques" which are hard to "break through." This is mainly observed amongst the "Asian" students. When asked what advice they would give to international students, most of the faculty members recommended that international students explore more interactions with peers as a way of gaining a deeper understanding of the culture. This is something that is discussed by international students as well, but there is variation amongst the students about whether or not this is a good practice. For example, one student that I interviewed felt a distaste for monocultural groups forming, particularly groups of individuals from his own country of origin, not because of the exclusivity of such groups, but mostly because he felt that monocultural groups continued the negative cultural habits of his country of origin and brought them into this new context and prevented full integration into American culture. This student made concerted efforts to avoid monocultural groups. This student, however, did not express feeling of restricted self-disclosure or issues with spoken English.

Language and cultural barriers. Amongst international students who did feel restricted by language in self-expression, these students also discussed cultural barriers, the lack of a common cultural history and, in particular, discord in humor. For example, one Chinese student brought up TV shows as a source of confusion, specifically when shows referenced American events prior to the 1960s. Two students discussed how it was difficult to make jokes with domestic students because the taste in humor was so different and that efforts to explain jokes to one another made the exchange seem pointless. Another Chinese student whose social group consisted exclusively of other Chinese students, indicated a deep desire to interact socially more frequently with domestic peers, but mentioned

that something was different or that "there are no sparkles[sic]." When asked why he has a desire to engage with domestic students, the student responded that it was always a good policy to get to know different people. In this way, it appears that international students desire to heed the advice of faculty members to integrate with peers, but a deeper desire for close companionship seems to pull them toward more familiar and, perhaps, more easily formed, friendships.

In general, international students discussions were more focused on practical concerns, like finding a high-paying job or visa status, and discussions with faculty were more focused on themes in the Ideals/Beliefs category.

Visa Status. The major theme discussed by all international students was "visa status" and all students mentioned that this was an obstacle to their career goals and even research goals. Students discussed "visa status" in terms of the limited duration of their student visas and in terms of any future sponsorship needs of the H-1 work visa. All students expressed feelings of lacking personal agency in the visa acquisition process, although students differed in their reactions to this lack of agency. Half of the students were anxious and worried, while the other half felt that worrying was not useful in a process they had no control over.

All faculty brought up the theme of "language" during their interviews. I differentiate between spoken language and written language in my analysis and discuss these findings in detail under the section "Language."

Motivations for Research. International students report that their major motivation for pursuing graduate studies in the U.S. is the desire for an intellectual challenge that they would not normally have gotten in their country of origin. The two students from India (who had worked for some years in their country of origin before pursuing doctoral studies in the U.S.) reported dissatisfaction with work, a boredom which led them to seek other opportunities. Most of the international students report that they chose the

U.S. over other countries because the U.S. has a reputation of intellectual freedom and good research.

Faculty, in general, get the sense from international students that they are very much driven by external pressures from family and peers, a desire to seek prestige or by a desire to please their parents (filial piety). Faculty reported that international students often define success by the acquisition of a high-paying job in the U.S. rather than the gaining of knowledge. This latter point is particularly frustrating, it seems, for faculty, as their main expectation is that students are propelled by interest in a topic and are driven by internal motivations like intellectual curiosity.

Thus, there is some incongruity between students' self-reported pursuit of an intellectual challenge and faculty perceptions of international students as individuals motivated by external pressures and filial piety.

#### *Major Hindrances to Progress in Doctoral Programs.*

##### Visa Status.

One issue that affects international students work is "visa status" both their present student visa as well as visa sponsorships post-graduation. For student visas, the limited duration of their visa looms large in the minds of international students. Most international students interviewed report feeling a time pressure to graduate and avoid the risk of going through the visa renewal process, which they view as tedious. When the first author mentioned creativity in research during interviews, one international student reported that he has many research ideas, but often inhibits the expression or pursuit of the more "high-risk" projects because he feels the deadline of his visa forces him to be more practical in project selection and favors the pursuit of projects with a higher probability of success. Not all students interviewed expressed such an explicit connection between visa duration and research productivity, but all expressed an on-going anxiety over immigration issues. This is one major

explanation for the perceptions faculty have that international students are less creative and more externally-driven. In terms of post-graduation employment, most international students feel that since they have the added burden of visa sponsorship needs, they are less favored by employers and additionally limited in their options for employment.

In the present study, all international students at some point during the interview characterized visa status as a hindrance to both progress in the doctoral program and long-term career goals. In contrast, only one of the six faculty members even brought up the issue of visa status and acknowledged it as one of the "hurdles international students face upon graduation." This faculty member believes that it is the personal responsibility of the student to deal with visa acquisition issues and did not elude to any ways in which visa status may influence international students work during their doctoral program.

Language. According to faculty members, the major hindrance to progress in the doctoral program for international students is language. All but one faculty member brought up spoken language as a barrier to communication between themselves and international students. Most faculty speak of this matter-of-factly and with an air of acceptance. Most faculty members do not feel that this is a major problem for engineering fields. As one faculty member put it "What we do is mostly math and equations, you know?" Faculty adopt various methods for communication with international students such as drawing and writing during discussions or the use of diagrams. One faculty member brought up soliciting repetition from international students by asking them to say things again or in different ways as a means of teaching verbal communication. All faculty members mentioned that extra patience was needed; however, I did not get the sense that this was said begrudgingly, but rather more with a genuine sense of concern for the student. In fact, one faculty member explicitly made comparisons between the patience needed with students and that needed for one's own

children.

One faculty member specifically mentioned that he/she did not have issues with Indian students in terms of spoken English. The faculty who said this attributed the lack of trouble to the fact that English is broadly spoken in India and is often learned from childhood concurrent with the students' familial language. However, almost all faculty brought up writing in English as an issue common to all international students for whom English was not their first language. Three of six faculty members brought up poor written English skills as an issue that slows down the manuscript preparation process more for international students than for domestic students. However, in this case, as with spoken English, most faculty interviewed consciously adopt methods for working with the students including walking international students through edits and providing explanations for each edit. This aligns well with the self-reported struggles of some international students about written English as something that slows down their progress. As one student put it "it takes me much longer to write an email. I read it over and over."

For international students, discussions of language as a hindrance to research progress tended to be focused on improving their writing skills and less about spoken English. As discussed in a previous section, spoken English was seen as more of a hindrance to social rather than professional relationships. Thus, I focus my discussion here in written English in the professional setting and specifically for Chinese international students. While all international students interviewed brought up spending extra time with faculty mentors working through manuscripts for publication or presentations, Chinese international students spoke about this experience as if they felt that it was an inconvenience to the faculty mentor. The Chinese students used language to describe the experience as a sort of thing that faculty mentors should not need to do with them but had to because they had a personal weakness. No student mentioned seeking help from campus

writing support organizations.

*Long-term Goals.* All international students in this project expressed a desire to work in an industry job in the U.S. Although some students expressed an interest in academia, most cite their older age or lack of teaching skills as a reason for not pursuing an academic career. The students who expressed these hesitations were older (28+) and had worked for some years in their country of origin prior to beginning graduate studies in the U.S. Interestingly, the one student who did express a viable interest in academia had not worked and joined a graduate program in the U.S. directly following undergraduate studies in his country of origin. When asked to describe what they looked for in a future job, half of the students responded with a desire for a "high salary" and discussed feelings of responsibility to financially provide for a future spouse and children as the primary reason for this desire. One student believed this was an advantage of an industry job, but contrasted this with the intellectual freedom available to academics. One student also mentioned that he wanted a job where he felt like he was "doing something" or that he was affecting some kind of change in the world, but made no comparisons between academia and the industry which would be better for achieving this goal.

The Chinese students, in particular, discussed some factors influencing the decision to stay or go back to China. These included more opportunities in the US because of less competition and more developed scientific research in the U.S. A major hindrance to returning to China is the high competition experienced by job applicants. Students state that having a degree from an American institution is not a competitive advantage because so many people have degrees from the US.

The main goal of faculty in this project in terms of mentorship of doctoral students for the future was to foster independent thinking, creativity, and self-guided, curious learners. Most faculty members interviews speak of independent thinking as a nurtured virtue unique to

training at an American university. Some faculty members have the impression that this kind of mentorship is what international students seek when they attend an American university. Thus, faculty attempt to nurture these beliefs and ideals in all students - domestic or international - regardless of desired career or geographical location of work. Faculty believe that this is an asset that is as important in industry as in academia. Most faculty members interviewed described methods or techniques used to help nurture students in this way. In terms of the perceptions that faculty have of international students' goals, most believe that international students are more likely to seek industry employment in the U.S. and most mentioned that "Asian" students are more likely to be driven by external pressures when making career choices than the pursuit of personal interest. Most faculty members use language which suggested to me that they believe the pursuit of personal interest to be a better motivator for career decisions.

Despite these views, faculty members do not tend to make distinctions in the ways they give career advice to international students versus domestic students. Although, of the faculty members who mentioned that Asian students are motivated by family pressure when they go to choose careers, two members differed in their methods for counseling. Both felt that students should be self-motivated or driven by his/her personal/intellectual interests, but where one professor explicitly advised students to practice "self-examination" in order to encourage a more self-directed career choice, the other professor strongly attempted not to change or influence students' motivations.

## DISCUSSION

For international students in this study, as in other studies, present and future visa status is a large source of anxiety (Arthur and Flynn, 2011). Meanwhile, faculty members, in general, are unaware of the ways that visa status influences student performance. The limited durations of student visa allocations loom large in the minds of international students during their doctoral

programs and may directly or indirectly influence the professional decisions they make. For example, opting for low-risk research projects that allow them to finish on time over higher risk, more creative ideas. This perhaps has facilitated the perception amongst faculty that international students are less creative researchers. This insight alone may better inform faculty as they develop mentorship methods for international students, and may also help international students realize a source of their research decision making. When considering motivations for doing research in the U.S., however, international students discuss the desire for intellectual freedom and an intellectual challenge, which is a desire that education-focused faculty in the U.S. yearn to nurture in their students. I urge faculty to take this opportunity. However, one barrier to this action may be the belief held by North Americans that concepts like intelligence and creativity are consistent (and not learned) characteristics of an individual (Heine, 2001). Thus, faculty members at American universities may not make attempts at teaching creative thinking because they simply do not believe that it is something that can be taught. In contrast, studies show that East Asian students believe that intelligence and creativity are the result of self-agency or environmental nurture (Heine, 2001) and may come to the U.S. seeking to be taught in this regard. Critically, the very idea of who the self is and the sources of identity differ between North Americans and East Asians and warrants consideration by educators (Heine, 2001). It may be beneficial to both faculty and international students to understand these cultural differences in perceptions of self, particularly with regards to the professional self. Additionally, faculty may benefit from articulating the steps of creative thinking for international students as a means of gaining a better understanding of their own process of research design.

The idea of motivation appears to represent a strong case where we observe misalignments between student self-reports and faculty perceptions. In terms of motivations for doing research in the U.S., international students are

motivated by the pursuit of an intellectual challenge, which can be seen as an internal or intrinsic motivator that is not contradictory to the desire of faculty members that students should be motivated by intrinsic factors. Crucially, however, faculty members perceive that international students are driven by external factors such as familial pressures and prestige. The author observes that international students do not feel a contradiction between their desires for an intellectual challenge and their desire for attending a reputable university. This pattern holds when discussing long-term career goals. Faculty perceive that international students are particularly driven by external pressures and the desire for practical definitions of success, while many international students report that desire but do not feel that this is inconsistent with a greater pursuit of intellectual challenges and participating in a career vocation that attempts to create some change in the world. The key issue appears to be that faculty members prefer students to be intrinsically motivated and international students are perceived as more extrinsically motivated. Although the faculty in this study claim to show no partiality in mentorship practices despite noticing this difference, insight into the views of international students may work toward breaking some unspoken barriers to mutual understanding.

I reason that this focus on extrinsic motivations could, in part, be explained by the fact that many students feel that it is a luxury to pursue intellectual freedom, and, therefore, it should be subsidiary to the pursuit of a stable job, which represents a practical, and therefore valuable and productive, goal. Second, I observed that the limited duration of student visas looms large in the minds of international students and could represent a pressure which causes international students to make more practical decisions at the cost of more belief-driven goals.

Third, the misalignment in faculty perceptions and international students self-reports could be explained by our psychological propensity to attribute extrinsic motivation to others. Heath (1999) shows that individuals are more likely to attribute motivation by extrinsic incentives

onto other people than they are to themselves. Additionally, this bias is stronger for "others" that belong to an out-group rather than an in-group (Davidai et al., under review). For the present work, it seems related to my findings that faculty members may see international students as more likely to have extrinsic motivations than domestic students (who may be considered more like them, unlike international students who are more seen as "other"). Actually, the idea that extrinsic motivations are seen as somehow less noble or desirable than intrinsic motivations may be a false dichotomy of sorts. Research suggests that the definitions of extrinsic motivations are varied and can reflect concepts of external control rather than true self-motivation (Ryan and Deci, 2000). Also, faculty should be aware that often when international students discuss a desire for a "high paying job" or a "good job" that this desire is deeply tied to the international students view that these are a means for providing for family or performing their human responsibility to care for the family.

Regarding the pervasive perception held by faculty that Asian students "clique" together, faculty recommended that students get to know other cultural groups more. Students tend to recommend this to each other as well and yet the phenomenon continues to persist. Studies confirm both faculty perceptions and concerns over monocultural "cliques" amongst international students. International students indicate a stronger preference for friends from the same country or students from other nations over students from the host country and indeed, despite, initial fervor for intercultural friendships upon matriculation at a host institution, social groups tend to be monocultural over time and consist of international students from the same country of origin (Bochner et al., 1977; Brown, 2009). However, international students who engage in friendships with American students tend to adapt and adjust more easily to the new country (Bochner et al., 1977). In the present work, the two Chinese students report a deep desire to understand American culture and interact with domestic students with the understanding that this may be the social environment of

their future, or some other utilitarian rationale for engaging with domestic peers. Thus the knowledge and desire is there. However, students also report a distance or barrier between self and domestic students. Both students had trouble precisely articulating the nature of the barrier, but both report that the distance is most evident in the realm of humor. Thus, it is possible that despite intentions to integrate, international students do not feel strong social support from student peers from the host country and thus seek support from friends from the same country or other countries presumably because these individuals share a common experience (Bochner et al., 1977). Thus, this effort to integrate and create multicultural social groups faces something much deeper than simply facilitating “knowledge” of other cultural groups, but rather needs to focus on cultivating feelings of relatedness and mutual reliance in order to be successful. Faculty need to be aware that monocultural groups can often form contrary to the intentions of individuals and reflect more so a psychological desire for social support and belonging rather than a willful exclusion of individuals.

With regards to special programs and social events hosted by the university or individual departments, international students in the present study, in general, desire to be undifferentiated from domestic students. They express desire to be left alone and allowed to explore the American culture without the creation of separate events for internationals and instead a chance for individuals themselves to initiate interpersonal relationships between international and domestic students.

On the subject of differential treatment in the professional realm, faculty and international students tend to see eye-to-eye. The following quote from one student characterizes well the sentiment expressed by both faculty and other international students:

*Professors in this department don't treat international students differently than domestic students. The nationality is not the key point. The intelligence and the IQ and EQ are the things*

*that matter, right, as a graduate student[?] It's not their nationalities. What matters is what they can do, whether they can do a good job, whether they work hard, and whether they are healthy. And these are more important than what language they speak.*

However, Lee (2010) found that a large online sample of international students from non-white regions at a large public university in the southwest region of the U.S. report more negative experiences in general, and in particular, felt that there was unequal treatment between themselves and others. This reveals that students perceive that they are treated unequally, and that this population, at least, seems to hold the belief that unequal treatment should not occur. I extrapolate this discontentment to be a discontentment with discrimination but do not specify whether this is racially-motivated discrimination or not.

My own interviews suggest that international students do not experience differential treatment as a result of racial discrimination. When they do experience differential treatment professionally, they tend to think that this indicates a personal failure to integrate into the workplace or acquire the necessary skills to succeed. My interviewees view unequal treatment as an unwanted “pity” in some sense and an indication of their own failure to improve their weaknesses. As one student put it, “If they have to do something different for me, then that’s not good, right? I should be able to do it.” Lee (2010) provides an interesting contrast to my own findings, although the differences may be explained simply by the fact that these are different schools. It could be that the students in the Lee (2010) study were referring to racial discrimination or racially-based inequality, while the students in the current study don’t seem to be discussing racial discrimination but rather differences in skills that stem from cultural unfamiliarity with the U.S. However, students do differ in their view of this. For example, one student I interviewed recommended that the department should hold a career fair specifically for international students in which attending companies are ones which openly express an intention to provide H-1 visa spon-

sorships for internationals. The varying reactions of international students to differential treatment is a topic worth further exploration, in particular with regards to what differential treatment means to international students.

## DISCLOSURE/CONFLICT-OF-INTEREST STATEMENT

This research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

## ACKNOWLEDGEMENT

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## AUTHOR CONTRIBUTIONS

MTT conceived of, conducted, and wrote the report for this work.

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## FIGURES

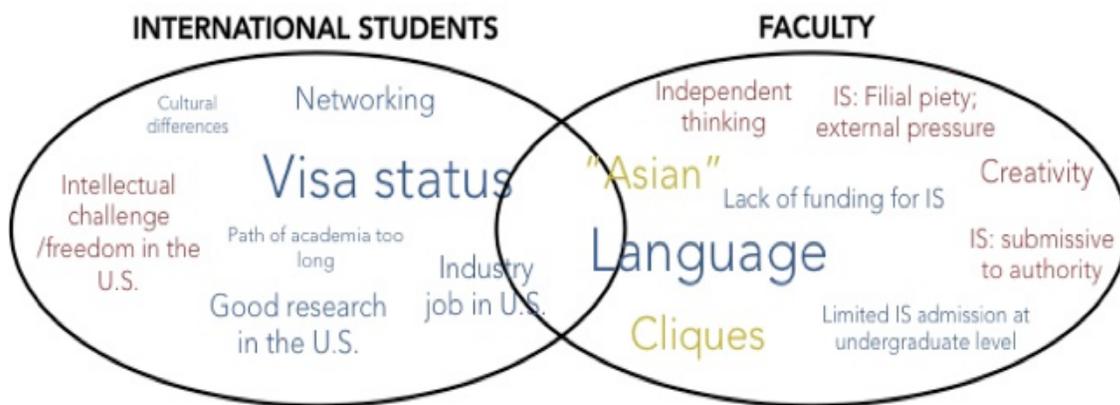


Figure 1: Word Bubble of Themes

Red represents themes in the Ideals/Beliefs category, Blue represents Practical Concerns, and Yellow items are those in the Observations category. In this Venn diagram, items that fall only in the area circumscribed by the "International Students" ellipse represents themes discussed only by the international students interviewees; similarly for items only in the "Faculty" ellipse. Items in the area of overlap between the two ellipses represents themes discussed by both faculty and international students. The extent to which an item falls into this area represents the proportion that the theme was discussed by both parties. For example, "Visa Status" was mentioned by all international students and only one faculty member, whereas "Industry job in the U.S." was mentioned by all international students and 4 of 6 faculty members.

# Any Person, Any Study: Race and Writing in the Cornell First-Year Writing Seminar

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## Abstract

My project analyzes how we engage undergraduate students in learning about race in the first-year writing seminar from both student and instructor perspectives and with both quantitative and qualitative findings. Through 54 student survey responses from four first-year writing seminars and six interviews with current graduate student instructors, I have compiled information on the effectiveness of current teaching techniques and student attitudes toward race. My findings indicate the effectiveness of a holistic and diverse approach to best practices in terms of teaching race alongside writing, with a special focus on the importance of discussion in the seminar as a horizontal and active mode for students to engage difficult topics such as race. The greater scope of my project analyzes how Cornell uses the “Toward New Destinations” diversity initiative and recommends how Cornell can better employ the first-year writing seminar as a site for furthering the goals for students to have serious intellectual involvement in race as a facet of diversity.

## INTRODUCTION

In 1868 Ezra Cornell declared, “I would found a university where any person can study any subject” (Kammen 54). As historian Carol Kammen notes, Ezra Cornell and A.D. White’s choice of language meant a radical commitment at the time: “‘Person!’ What a revolution in a word: ‘person’ meant anyone of any or of no religious affiliation, of either gender and of any race” (52). But change does not come easily: despite Ezra Cornell’s belief in coeducation drawn from his Quaker background, it took until the fall term of 1874 for the university to formally open admission to women (Selkreg 447). The continuing difficulties faced by the “any person, any study” informal motto of Cornell University is illustrated by such events as the activity of the Ku Klux Klan in Ithaca, who lit a cross on Libe Slope in 1924, and the racist invective referencing Trayvon Martin hurled along with bottles at African

American students from the Sigma Pi frat house in May 2012 (Kammen 97; Coscarelli). In recent years, Cornell University developed an institutional diversity planning initiative “Toward New Destinations” as part of its statement “Open Doors, Open Hearts, Open Minds” (2000). This framework is meant to impact every group on campus, such as undergraduates, graduates, staff, and faculty, and requires every college and administrative unit to undertake annual diversity initiatives in the areas of composition, engagement, inclusion, and achievement. As of this writing, the new incoming class appears to address the compositional element of the initiative: 52.7% of the class are women and 46% identify as students of color, with 25.7% specifically from underrepresented minority groups (Aloi). But in this study, I ask, how does a university-wide diversity initiative such as

“Toward New Destinations” trickle down from the administration to on-the-ground teaching and learning practices?

This project is two-fold: I set out to understand the attitudes around race as a facet of diversity and to compile best practices for the teaching of race in the first-year writing seminar from the perspectives of both students and instructors. The greater scope of my project is to critique the gaps that can often come in the implementation of an initiative across such a large and disparate institution like Cornell and suggest some strategies for a fuller engagement with the ideal of “any person, any study” that goes beyond mere composition. Coincidental to the development of Cornell’s diversity initiative, I began my journey as a university instructor of first-year writing seminars at the institution in Fall 2011. As a scholar of nineteenth-century American literature, it was never a question for me that the topic of race, along with issues of gender and sexuality, would enter my classroom and become an important component of discussion and assignments. In my first two first-year writing seminars under the “Memoir and Memory” rubric, I taught slave narratives such as Frederick Douglass’s *Narrative of the Life of Frederick Douglass, an American Slave* and Harriet Jacobs’s *Incidents in the Life of a Slave Girl*, as well as Maxine Hong Kingston’s classic of Asian American literature, *The Woman Warrior*. While students from all backgrounds were enthusiastic about the texts, I found them reluctant to substantively engage the deep and complex issues of race in discussion and in writing without resorting to bland and broad statements that unthoughtfully reified the present as an American post-racial utopia and vilified the past as an amorphous racist era long past. Since my first semester of teaching, I have worked to fine-tune the tactics and strategies of my pedagogical practice to confront these difficulties head on and to take seriously the potential for my first-year writing seminar classroom to be a site for serious intellectual engagement with race.

The impetus for my project comes from my own experiences as an instructor and grows

from the need I see among my colleagues and students for academic engagement with race in the classroom. Too often do I come across complaints about the ignorance of undergraduates and the often inadvertent offensive comments made during discussion or in assignments. Tactics for dealing with these situations are often impromptu or require informal solicitation of people’s opinions via social media. While networks of teaching mentors exist, with some collaborations officially supported by the Knight Institute for Writing in the Disciplines, as do workshops for graduate student instructors through the Center for Teaching Excellence, I believe a more systematic approach to supporting instructors in order to in turn support their students in the engagement of race is required. It was only through my work in the Graduate and Professional Student Assembly did I begin to hear about the “Toward New Destinations” initiative and get a sense of how Cornell as an institution is supposedly working toward a multi-faceted approach to diversity. My project on race and writing in first-year writing seminars is a preliminary step toward gathering best practices and offers suggestions to address the current shortfalls on both an individual pedagogical level as well as on the scale of the university as a whole.

## SURVEY OF LITERATURE

My literature review consists of two types of sources: the first is a broad look at the overall issue of diversity and race in the teaching of humanities higher education, often through a theoretical lens, while the second category concerns itself with more specific studies of texts and techniques. In this way, I have surveyed relevant resources for both the institutional and specifically pedagogical aspects of my project.

My major source for background on the structure of diversity in higher education is Sara Ahmed’s 2012 monograph *On Being Included: Racism and Diversity in Institutional Life*. Ahmed’s work on this subject is notable since she has made her name as one of the major literary critics who theorizes about race, colonialism, and sexuality; her application of theory

to real life institutional praxis, phenomenology to ethnography, acts as an important starting point for my understanding of the connection between academic work and praxis. As a woman of color, she found herself called upon to sit on diversity committees and to write diversity mandates, eventually realizing that these documents had a type of power and life that could be analyzed through her work as a scholar. She ended up undertaking an empirical project by conducting twenty-one interviews in the United Kingdom and Australia with diversity practitioners in the higher education sector. Her discussion of this shift in methodology speaks to my project since she found it a major shift as a scholar in the humanities to go from analyzing texts to living subjects. Ahmed offers a far-reaching analysis of her subject by considering how the word "diversity" and the associated language function in institutions often for PR purposes versus the experience of diversity practitioners in said institutions that use the term to enact substantive change. She also interrogates whether diversity mandates actually create diversity and argues that commitment is perennially lacking. Finally, she evaluates how diversity works to combat racism as an attack on an institution's public relations and to push for a critical lens for how diversity is used to enact changes and what kind of change.

Ahmed offers a framework for my understanding of the meta-level of my project. While her perspective may seem cynical or overly critical, she speaks as a diversity practitioner who has been deeply involved in trying to bring a commitment to diversity to higher education. Diversity work can also impede the workings of an institution if it is truly meant to rearrange everyday habits and behaviors; comically, Ahmed includes a photo of a brick wall with the caption "A job description" (27). Sometimes, she notes, "Diversity work becomes about generating the 'right image' and correcting the wrong one" (34). Instead, "Diversity becomes about changing perceptions of whiteness rather than changing the whiteness of organizations" (34). In that case, "diversity" as a term has "a commercial value and can be used as a way not only of marketing the university but of making

the university into a marketplace" (53). At its worst, Ahmed insinuates that "diversity" can act as a simplified catchphrase that depoliticizes issues of social justice and substitutes branding for substantive change.

Another important background text is *The Critical Pulse: Thirty-Six Credos by Contemporary Critics*, a volume from 2012 that collects essays by leading literary critics reflecting on the field and their experiences. The writing style of these essays is a marriage of critical thought and personal reflection, further along the qualitative end of the spectrum than Ahmed's work. Leading Asian American critic Lisa Lowe's "On Critique and Inheritance" is a meditation on her work on Asian American history in relation to her professorial father; her evaluation of her critical stance, and how various forms of inheritance informs it, gives me a model for locating myself in my study. African Americanist Kenneth Warren's "On Race and Literature" is more about pedagogy: he talks about his agenda to teach literature from diverse backgrounds, walking through the teaching of a Japanese-American poem in order to caution how an overemphasis on race alone can lead to an obscuration of other forms of inequality.

In terms of more specific approaches to texts, the journal I found most consistently rewarding was *Pedagogy* from Duke University Press that has had several articles about teaching race and writing over the last several years. (The special issue of *Research in the Teaching of English* on diversity and international writing assessments gives me useful material on teaching writing to diverse audiences, but less about the teaching of diversity itself, which is the concern of my project.) To cover a few notable examples, Lisa King's article on American Indian texts and Andrew Hock Soon Ng's piece on using the Gothic as a way to read Asian American literature both promote the usage of key terms as a way to deepen the complexity of their students' understanding of their respective topics. Kay Siebler takes another approach in her consideration of teaching the politics of Sojourner's Truth's "Ain't I a Woman?" by framing the famous speech in relation to its historical layers and how to

guide students through how these contexts add complexity. This range of articles on the one hand functions to let me compare their methodologies on teaching race in relation to literature, and on the other, lets me compile a list of various strategies and teaching practices used in order to better direct my study of best practices and their execution.

These two bodies of pedagogical criticism I have identified serve to frame the context of my study and to give me a view of the tool box of techniques others use to teach race and writing in the context of literature courses in higher education. I can also identify the role that I play as a woman of color who must mediate her own experiences as part of her pedagogical persona, as discussed by Lisa Lowe, and how I serve as what Sara Ahmed identifies as the intertwined specters of the feminist killjoy and the diversity practitioner that “is heard as an obstacle to the conversational space before she even says anything. She poses a problem because she keeps exposing a problem” (63). My project adds to this discussion through the compilation of best practices that goes beyond the usual study that is centered upon the individual experience of the single author and teacher, uniting the consideration of technique and its teaching with the larger structures of higher education.

## METHODOLOGY

Like Sara Ahmed, I found that my project provided an opportunity for me to explore new research methodologies as someone with humanities training. I designed my project to incorporate both quantitative and qualitative forms of research, requiring IRB exemption. Since I was not teaching my own class this year, I had to solicit instructors in order to go into their classes, ask permissions, and distribute surveys. My focus was on the first-year writing seminar for a number of reasons. The first-year writing seminar, run through the Knight Institute for Writing in the Disciplines, is one of the few common experiences shared by all undergraduates at Cornell. Taking at least one first-year writing seminar is a requirement for the degree and two seminars are required for

students who have not previously taken AP English. The primary function of the seminar is to teach writing in the disciplines through at least six written assignments, accompanied by literature and material from the instructor’s field. The seminar size is also capped at 18 students in order to allow for more intimate and intensive academic engagement; this often means that the seminar serves as the smallest class a freshman will take, and as a course with the most instructor interaction, in an academic year where they may have mostly large introductory survey classes. The first-year writing seminar is also the primary opportunity for graduate students, particularly in the humanities, to serve as the sole instructor of a class. We receive training in the form of WRIT7100: Teaching Writing, which is run by a faculty member from the Knight Institute with the help of a graduate student co-facilitator. The course meets the summer before the teaching year or in the fall concurrent to teaching. Those who have had no prior teaching experience also take a teaching internship during the summer where two or more graduate students intern under a teaching mentor during the teaching of the summer equivalent of the first-year writing seminar.

I surveyed four first-year writing seminars in the spring term of 2014, with survey results from 54 students. None of them were explicitly focused on race, although it was a component of the instructors’ syllabi as a reflection of their research concerns and/or conception of what makes for important intellectual engagement. For instance, a seminar on American girl heroes read Toni Morrison’s *The Bluest Eye*, and race was an integral part of the discussion, even though the primary theme of the class was about gender and feminism. Student volunteers were recruited by a verbal explanation of my project and given a written recruitment form with the full parameters of the project; students signed and dated the forms to indicate their consent. I designed the surveys to have a combination of quantitative and qualitative questions in order to get the fullest range of results. The first several questions asked for demographic information, such as prospective major and academic year. The majority of the

questions were designed on the Likert scale: the first half gauged student attitudes about discussing and writing about race before and after their Cornell experiences. The second half broke down student perceptions about the helpfulness of different teaching tactics in learning about race: key words, guided class discussion, short writing assignments, essay assignments, and creative writing assignments. Finally, I gave them three open-ended questions: the first to inform them about “Toward New Destinations” and to see what students thought that should mean for their experience at Cornell; second, suggestions on improving how race is taught; and third, asking what students thought made a classroom lesson successful.

I complemented my surveys with six one-on-one interviews with first-year writing instructors, all of whom are graduate students in the humanities. I set up a general framework of questions for my interviews, although I also gave myself the freedom to follow the lead of my interviewees. Questions had to do with their perceptions of Cornell undergraduate attitudes about race, effective techniques, difficulties they have faced, and also what type of training they wished they had received in order to tackle these issues. Finally, the meta-level of my project is based upon analyses of my survey and interview data in relation to close readings of the language in institutional documents about diversity at Cornell.

## STUDENT SURVEY RESULTS

Almost all of the students I surveyed were freshman except for four sophomores. All colleges were represented: Arts and Science, Engineering, CALS, ILR, Human Ecology. Majors included many types of engineering, Biology, ILR, Government, Communications, Economics, French, Psychology, Animal Science, Human Biology Health and Society, Human Development, Hotel, Agriculture, and Computer Science. All of them had taken previous writing classes at a college level with a focus on language and writing, with 33 of 54 having taken one or more college-level classes focused on race and diversity. All students had to attend

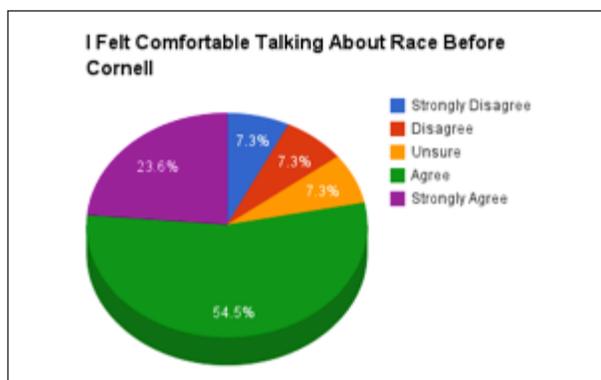


Figure 1: Comfort Talking About Race Pre-Cornell

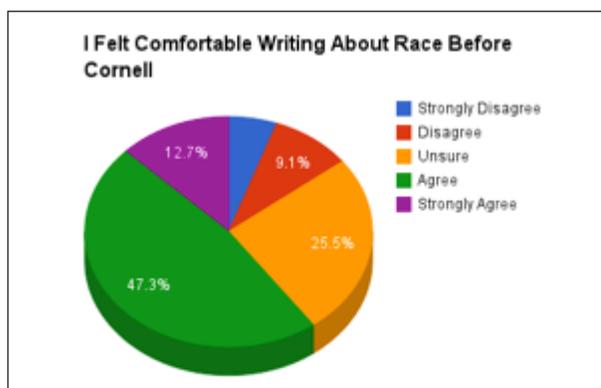


Figure 2: Comfort Writing About Race

Tapestry, a theatrical presentation on diversity followed by moderated discussion, as part of orientation. However, only three had taken any classes through the optional Center for Intercultural Dialogue. As Figure 1 and 2 indicate, while the majority of students claim to have felt comfortable both talking and writing about race prior to Cornell, the level of confidence is far higher when it comes to talking (54.5% agree; 23.5% strongly agree) than writing (47.3% agree; 12.7% strongly agree). When it came to writing, students were overwhelming unsure about their confidence level, perhaps indicating a lack of more formal and academic engagement with race beyond conversation.

In terms of how students view the importance of race in Figure 4, 40% agree, and the “strongly agree” response had its highest percentage in any category at 45.5%. As for the relationship between writing and race/racism in Figure 5, re-

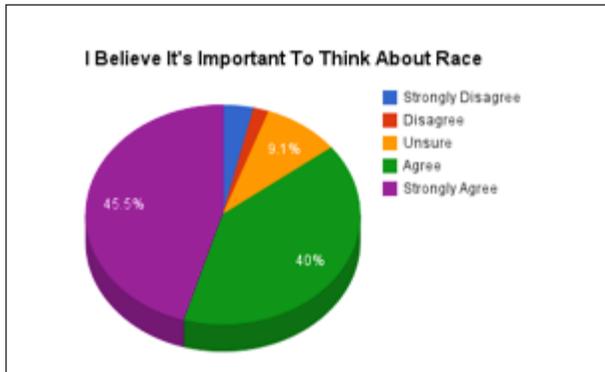


Figure 4: Important to Think About Race

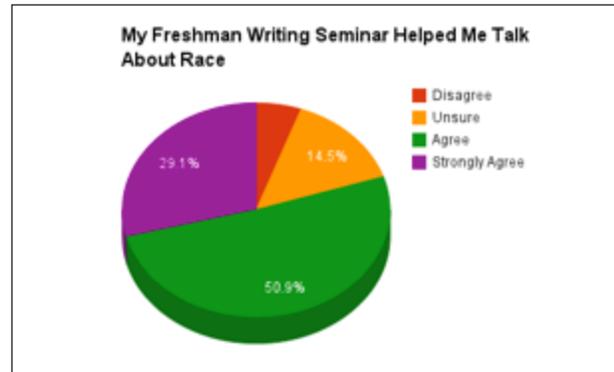


Figure 6: FWS Helped Me Talk About Race

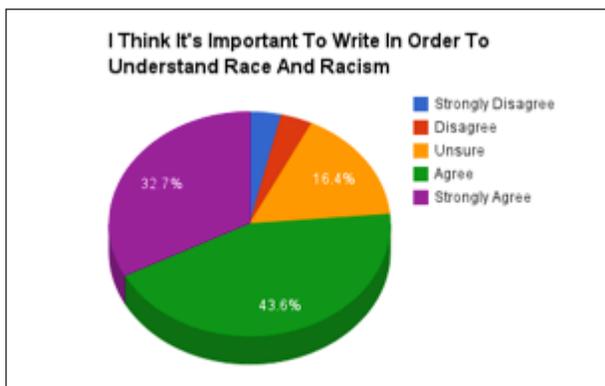


Figure 5: Important to Write About Race

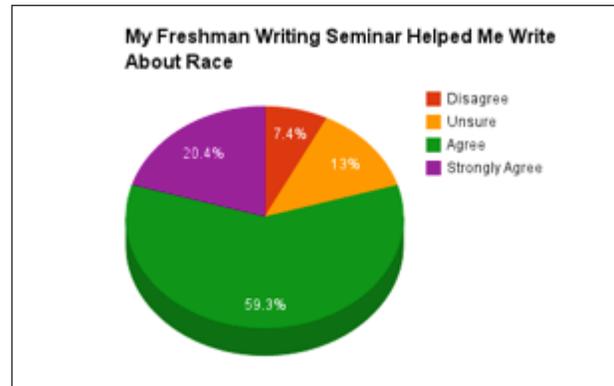


Figure 7: FWS Helped Me Write About Race

sponses were still strong with 43.5% indicating that they agree and 32.7% indicating that they strongly agree, although the level of uncertainty also rose from 9.1% to 16.4%. The negative responses were few, and overall the positive responses indicate that students on some level do believe in the importance of critically engaging with race, as opposed to avoiding it all together, or then again, these results may be influenced by what students believe they should find important either because of

broader social discourses or even the pressure of the classroom environment despite these seminars not having an explicit focus on race.

Regardless of the majority's alleged confidence

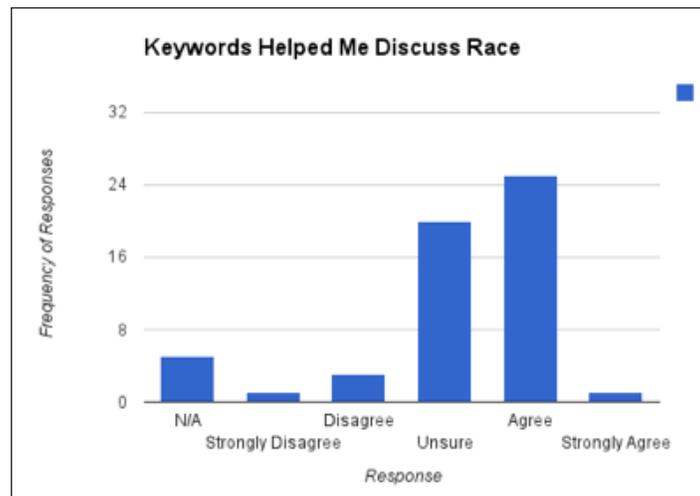


Figure 8: Keywords

in talking and writing about race prior to Cornell, Figure 6 and Figure 7 indicate the perception of the positive influence of the first-year writing seminar when it came to talking and writing about race. If these numbers are to be believed, the first-year writing seminar has a sub-

stantial impact on students' ability to engage race as a facet of diversity.

I created the part of the survey about teaching techniques in order to try and isolate best practices for the teaching of race and writing. The techniques I isolated reflect my own development as an instructor with a greater sense for new pedagogical angles to approach materials. From the literature review I did, it appears that it is easier for instructors to discuss race and pedagogy in terms of content and resources as opposed to techniques. By focusing on techniques, I hope that instructors will be able to adapt and transpose the panoply of effective techniques to their courses and content as needed. Turning to Figure 8, personally, in my own teaching, I quickly turned to keywords as a method for giving students critical terms such as double consciousness, intersectionality, and hybridity, in order to build up their comfort with complicated concepts. Keywords enabled them to enter an ongoing critical and historical discourse surrounding race in the various texts and materials we studied. In my own teaching, keywords were the first building block of competency in a thread that went throughout the class: once they mastered the definition, students could then use the keyword to enhance their discussions; I would have them practice paragraph-writing exercises with the keyword and build assignments around keywords so they could see how themes went throughout all the works we studied. My hope is that the repetitive use of keywords will tie into the student learning experience and demonstrate the portability of the concepts with potential for the terms to stay with students after the class is over. The usefulness of keywords is evident in the Keywords for American Cultural Studies project edited by Bruce Burgett and Glenn Hender: the short essays on keywords written by experts act as a jumping off point for teaching. Examples of words include "coolie," "Orientalism," "race," "ethnicity," "queer," and "abolition." In fact, the project has an online component called the "collaboratory" where different classes from around the country build assignments around the keywords and create a collabora-

tive discussion, treating the online space as a discursive laboratory. However, none of the classes I surveyed used this text and the high numbers for the unsure category indicate a lack of student knowledge about how keywords could be used or their effect.

The next two techniques are more conventional approaches to teaching writing. In my teaching, short writing assignments entail in-class projects which often include group work. The short writing assignments allow students to practice

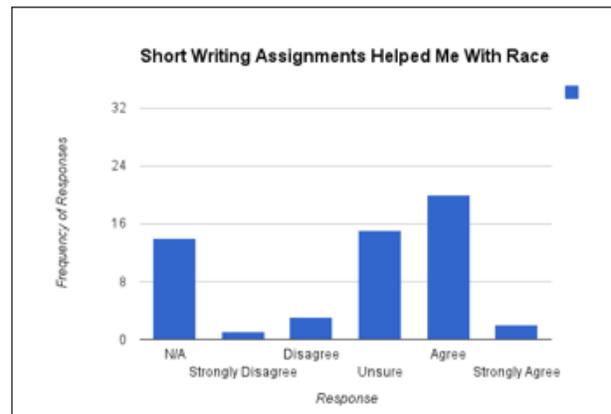


Figure 9: Short Writing Assignments

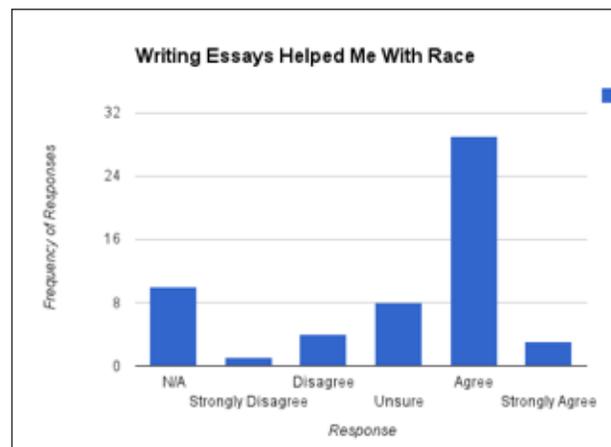


Figure 10: Essays

analyzing texts as well as to work on skills they can use in other writing, such as paragraph construction and punctuation; we can then use these short ungraded assignments for peer review and discussion about writing skills. However, the results of my survey in Figure 9

(on previous page) indicate that students overwhelmingly were unsure as to whether short writing assignments helped them with race. Figure 10 (on previous page) shows that the conventional essay is recognized by students as an effective means for them to engage with race. The essay allows students to develop a more extended argument about race, often with research. But despite the apparent efficacy of the essay, I caution that instructors should not be overly reliant upon this one obvious mode of engaging students with writing and research on any topic.

Figure 11 shows that while creative assignments were not applicable for a portion of stu-

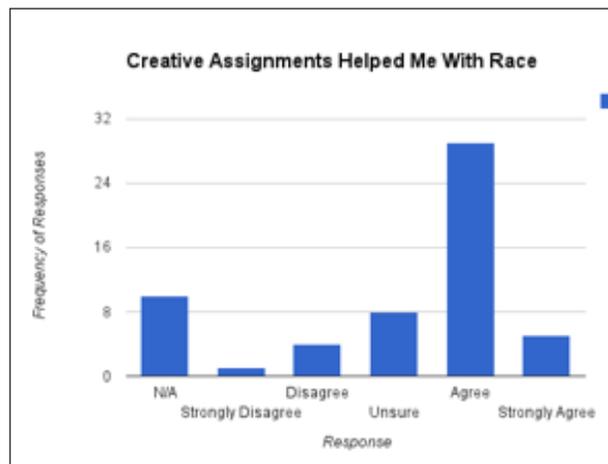


Figure 11: Creative Assignments

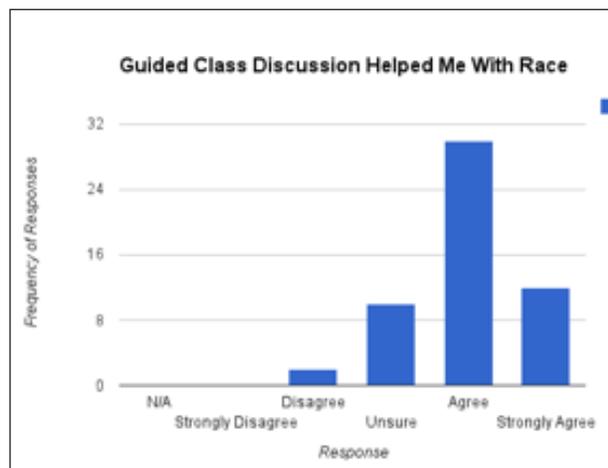


Figure 12: Guided Class Discussions

dents, when students did have the opportunity to do a creative project, they received a very strong positive response from students. Often the creative assignment involves a new way for students to engage with a writer’s language and other creative techniques; typically, the assignment requires a student to write in the voice of a character or to imitate the writing style and content of an author. This allows students to become more immersed in a subject and often in a point-of-view that is foreign to them. Moreover, the more open-nature of the creative assignments allows for more serendipitous explorations of the subject, not only for the students, but also for the instructors.

However, the most notable result from the technique portion of the student survey had to do with guided class discussions. As in Figure 12, guided class discussions had the highest level of approval in both the “agree” and “strongly agree” categories. Since the seminar format lends itself to discussion, it is the only universal strategy for all students. This result is also consistent with student attitudes both before Cornell and currently in that they are more confident in talking about race than writing about it. Turning to the open-ended questions about student suggestions for improving the teaching of race and their perceptions on successful lessons, despite the focus on writing, students overwhelmingly ended up talking about the importance of discussions. In part, discussions help to establish atmosphere and attitudes for learning: “Make sure all students feel comfortable with the teacher/students because discussing race can be uncomfortable/intimidating for some students” and from a few other comments, simply, “Talk about it more.”

Students find value in learning from their peers as much as their teachers, possibly because it can feel like a more organic mode of learning that encourages active participation; as a few comments said, “Encouraging all students to participate will bring different perspectives to the table” and “More discussion on the subject [will bring] in people with actual personal experience to talk about it.” One student explicitly highlights the horizontal aspect of discussion:

"I think it's important to have restrictions but at the same time I find unguided discussion to be more genuine." Over 90% of the comments written in response to the question about what makes a lesson successful highlighted open discussion, peer dialogue, and an enthusiastic teacher to guide them. Cornell has been pioneering pedagogical discussion techniques through the Intergroup Dialogue Project that emphasizes structured, peer-facilitated discussions of social justice issues; perhaps training overlap between this successful project and the seminar component of the first-year writing seminar would be productive since these resources already exist. Nonetheless, I do not recommend privileging any one technique over the other; if anything, the generally positive results for all techniques indicate the need for a diverse approach to pedagogical techniques that can work together holistically in the classroom since students respond in different ways to different tactics.

The student perspective also demonstrates curiosity about the temporal connections between race and open-mindedness and learning about race more broadly. A number of comments emphasize the importance of "reading texts from different time periods and places," but often betray a bias on the present. For example, one comment notes that the study of race "Should focus on or reveal biases that still exist in current times instead of just looking at the past," and another comment bluntly stated, "Use pop culture not material from pre-1965." Variety appears to be an important component of diversity for students as well. One student wrote, "There should be literature and examples about all races" and another student wrote, "One suggestion would be to have a diverse reading list in the freshman writing seminars and to not just focus on one culture." Some are also open to being more critical of Western culture, with one student stating, "It would be interesting to study Western society on its own from a sociological perspective because most of the seminars on race focus on minority groups" and "Students should be urged to identify and abandon westernized thinking when trying to

analyze diverse texts."

None of the students surveyed had heard of "Toward New Destinations" before, although many of them expressed approval for the idea of diversity. Some had a very positive approach, suggesting an academic and active component. Some comments included suggestions such as, "[Increase] diversity, awareness of other races and cultures and awareness of discrimination"; "Take at least one class that fulfills a diversity requirement"; "[Learn] and actually [experience] new cultures either through classroom environments or seminars and discussions"; and "A more diversified social scene. It should also mean a greater appreciation of diversity on campus. I sometimes feel people actually dislike the idea of diversity." Indeed, some were explicitly critical about the attitudes they observed and the institutional aspect: "More classes/more integration of race in classes. Include history of people of color and women in classes. People should get more knowledge about those who have been left out of history and college classes in the past," and "In a session I was recently in, we discussed the idea of colorblindness and the dangers of being colorblind. I think the university-wide mandate should encourage us to recognize what race means and how it affects our lives, and history, instead of just ignoring it."

A few focused on what it meant personally to their time at Cornell: "Making race studies unenjoyable is a great way to turn people off"; "I think this means I should have access to more types of people, cultures, etc.," and one rather confused comment, "Explore all of the resources offered to me at Cornell." A theme which emerged in a lot of the comments was pragmatically based on what they perceived as the coming future of a globalized world: "We should be exposed to at least one other culture different from our own so that we can learn how to be a part of the global society"; "I think diversity is definitely an important goal for any institution because we're in an era in which we need to establish unity"; and "To build a future with people from all races."

## INSTRUCTOR INTERVIEWS

I conducted six interviews with instructors of first-year writing seminars, four of whom were the teachers of the classes I surveyed. All of them were graduate students who had taught for more than one year at Cornell, and therefore were teaching their third seminar, and, in some cases, their sixth or seventh. The range of attitudes was pretty consistent: students were viewed as being eager to learn, but often starting from a positive albeit superficial view about race. One participant said,

*From my experience with mostly first-year students, Cornell undergraduates tend to begin the semester with well-meaning general attitudes about race and racism (i.e. they generally all agree that harboring personal feelings against someone because of their race is bad) and equally well-meaning, if interrogated, notions of universal humanism (i.e. "we're all human so we shouldn't worry about 'superficial' differences between people"). What's missing, though, is an awareness of and sometimes willingness to think and talk seriously about race and racism as being something tied to larger power structures. The focus is often on personal as opposed to structural racism, and there is little historical perspective other than "the country used to be very racist because of bad things like slavery and Jim Crow which – thank goodness – are totally over so we don't have to worry about them anymore." The most difficult thing to do in conversation about race (again, for me thus far), then, is to shift focus onto the ways in which race is a both a fiction (as a social construct) and a lived reality (due to the material consequences of racist power structures).*

Indeed, the primary challenge for instructors appears to be not just addressing ignorance, but pushing for more critical and nuanced attitudes about race.

Instructor perspectives on techniques often had to do with context and comparison in order to frame a text's background as well as to try and relate material to what was familiar to students.

One instructor found it useful to show students documentaries as well as to let them read texts by Native peoples as well as texts about Native peoples from white perspectives, allowing students to draw their own comparisons about the difference in representations. Another emphasized the importance of bringing in primary materials for contexts, such as racist advertisements, movies, and songs to make a racist past more real for students. Drawing attention to the nuances of language was also a reoccurring theme in instructors' arsenal of tricks; for example, an instructor emphasized the "both/and" construction in order to overcome "either/or" binaries of thought. It's also notable that when I gave my interviewees free rein to discuss how they went about their teaching, none of them used the categories I had established for techniques. Since it appears that comparison and context are the go-to strategies for teaching complicated issues such as race, I hope that my emphasis on transferable forms of teaching assignments and techniques can help to diversify the pedagogical arsenal.

Like the students, none of the instructors had heard about the "Toward New Destinations" initiative. Reactions on the type of support instructors of first-year writing seminars should get when discussing race were mixed. While all thought it was important to get some kind of guidance, some were skeptical about the ability of institutions such as the Knight Institute or the English department to provide support. One participant said, "Any support they did offer would be, of necessity, institutionalized, and I imagine pretty sterile. I'd be afraid that they would encourage teachers to 'de-politicize' the issue of race in the classroom, which I think would do more harm than good. I'm not sure I trust the institution, honestly, to be helpful in these matters." Others had clear suggestions for how guidance on teaching race could be integrated into current programs. One participant commented, "There should be a panel on this subject, or maybe a seminar (but I suggested a panel because not everyone going through the training has had teaching experience/ was sensitive to the mishandling of minority texts and

cultures as a student).” The current experience of WRIT7100 lacks this aspect: One participant said, “I was incredibly dismayed that the only reason we ever talked about power dynamics in the classroom and how to approach issues of difference like race and class in the FWS classroom while I was in my summer Writing 7100 course was because I personally insisted on using a presentation assignment to provoke discussion of power dynamics.” As this one instructor notes, it is not that all first-year writing seminars should be obligated to have race or diversity as a component of their teaching, but rather that everyone should be trained to think about race when race or other heated issues come up, and to be aware of power dynamics in the classroom and in the works they study. A few other strategies for integrating critical pedagogy about race into instructor training that came up in interviews include: discuss power dynamics as part of classroom management and discussion; have faculty come to talk about lesson plans for talking about race; and encourage cross-disciplinary discussion of race.

## CONCLUSIONS: DIVERSITY INITIATIVES AT CORNELL

To reiterate, neither the undergraduate students nor the graduate student instructors had ever heard of “Toward New Destinations,” Cornell’s diversity initiative. This widespread lack of knowledge begs the question of how diversity as a term functions at Cornell and for whom the initiative is meant; to recall Sara Ahmed’s work, diversity can operate as image control for the university, as a corporate entity rather than initiating substantive change. On Cornell’s website for Diversity and Inclusion, the opening paragraphs primarily emphasize the aspect of public image in the marketplace of higher education as a way of remaining competitive and increasing perceived value:

All world-class academic institutions recognize that research, knowledge production, and intellectual and operational pursuits benefit tremendously from full engagement with diverse points of view coming from varied life experiences and

ways of interacting with and interpreting the world. To be on the cutting edge of our fields and practices, Cornell is committed to enhancing our culture for the full participation of all members of our community. Recognizing that historical circumstances and social structures produce imbalances in privilege, power, and opportunity, we know that this work in support not just of access, but of deep participation, is a complex, long-term effort.

The historical and structural aspects of inequality are acknowledged, but only in service for the mission of Cornell maintaining its institutional status. Would the university articulate this commitment to diversity for its own sake if there were no relation to the development of norms that “world-class academic institutions” should hold? Arguably, the nameless diversity practitioners who may have written the public face of this statement for the website needed to moderate the terms of the change they wanted to enact at Cornell through acceptable institutional language; the price of getting an institution such as Cornell to commit to diversity may be a necessary compromise with the demands of the institution as a competitive academic entity. Perhaps, as Sara Ahmed suggests, the depoliticization of diversity is inevitable within an institution.

To the university’s credit, in Fall 2013 the university engaged Sylvia Hurtado to do an independent qualitative assessment of students’ perspectives on diversity which is critical of the work that still needs to be done. This report is publicly available on the university’s Diversity and Inclusion website, inviting accountability. In Hurtado’s executive summary she writes, “A common theme was lack of awareness and examples of how some students, faculty, and staff ‘just don’t get it’” (4). The asymmetry in knowledge and responsibility means that those from minority communities “often have to take on the ‘burden of educating others,’” and sometimes find themselves without support, especially when faculty or staff are those who are ignorant and unprepared (4). In my own findings I tie this in part to the universal ignorance about

"Toward New Destinations." Throughout Hurtado's report she highlights "opportunities for action" that point out that "Common residential experiences like North Campus are natural sites for additional programming. The nascent Intergroup Dialogue Project is promising, but it needs to be scaled up and/or take place in many more units" (4). Furthermore, she writes, "We recommend faculty development activities to provide support for inclusive pedagogies, activities, and/or content that addresses diversity, which could become part of the teaching portfolio at promotion and merit evaluation" (4). In order for Cornell to further develop the goals of "Toward New Destinations," the university must work to advance "natural sites for additional programming" and further support pedagogy surrounding diversity.

In this light, my project is a more precise recommendation for how a facet of the diversity initiative's focus on engagement within the academic framework can be achieved. The first-year writing seminar has great potential as a common site of academic engagement for all undergraduate students at Cornell and, as my research has shown, is already able to achieve much work in terms of getting students intellectually involved with questions of diversity. My findings point to the efficacy of various techniques and indicate that students are open to a more intensive intellectual curriculum centered on race and other forms of difference. The demand that Hurtado's report notes for faculty development activities is also a need for graduate students who are being trained as future faculty members and are currently the majority of the instructors for first-year writing seminars. In order to truly honor the university's legacy of "any person, any study" I am calling for changes in the understanding of what the first-year writing seminar can achieve, the current setup of the WRIT 7100: Teaching Writing training through the Knight Institute, and pedagogical support for teaching and diversity that may profit from more overlap between the Intergroup Dialogue Project. In the summer of 2014 I am going to be working a graduate co-facilitator of WRIT7100 and in my group at least I will be trying to enact

the awareness of pedagogical approaches that require a greater sensitivity and understanding toward issues of diversity, inequality, and power. But I am only one person – and it seems for a problem like racism that is systemic, a systemic answer is required.

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# Culture in the Language Classroom: Student Perspectives

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## INTRODUCTION

Universities and colleges in the U.S. are setting new goals for internationalizing their campuses and strive to prepare their students for entering a global workforce. These university policies do not only impact international student admission quotas and study abroad programs but they also focus on designing curricular frameworks for helping students hone their intercultural competence. However, questions of how to help students develop (inter)cultural competence and how to assess it are not new. They have been the focus of research in the fields of education<sup>1</sup>, second language acquisition, intercultural psychology, and beyond. Applied linguistics and second language acquisition have participated in these efforts by highlighting the role cultural learning plays in the language classroom and how it can help students develop intercultural skills that will serve them beyond the academe.

Over the past two decades these two fields have produced substantive scholarship that conceptualizes a theoretical framework for teaching culture in the language classroom, discusses institutional challenges and limitations faced by language teachers who are trained in applied linguistics but have no background

in cultural studies, and outlines models for assessing intercultural competence (Kramersch, 1993; K. Byram and Kramersch, 2008; M. Byram, 2000). The Common European Framework of Reference for Languages: Learning, Teaching, Assessment (CEFR), a project with political implications designed by the Council of Europe to create common guidelines for foreign language learners across the European Union has also served as an interlocutor and inspiration for North American second language scholarship on culture. In particular the CEFR model of a language dossier and autobiography of intercultural encounters serve as spaces for the student to document, reflect, and critically analyze cultural experiences.

The way in which second language acquisition scholarship defines notions of culture has changed over the past two decades. The field shifted away from defining culture in the language classroom in terms of the history and language of the nation state to more along the lines of a dichotomy of "native" vs. "target culture." Today, the focus falls more on tolerance and acceptance of ambiguity in cultural communication, as well as on developing a critical toolkit for analyzing experience. In her 2010 plenary speech at the Second International Conference for the Development and Assessment of Intercultural Competence, titled "The symbolic dimensions of the intercultural," Claire Kramersch,

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1. See Deardorff, D. K. (2009). *The Sage handbook of intercultural competence*. Thousand Oaks, Calif: Sage Publications. for a detailed discussion on assessment of intercultural competence.

one of the leading scholars in the field, defines culture as “a mental toolkit of subjective metaphors, affectivities, historical memories, entextualizations, and transcontextualizations of experience with which we make meaning of the world around us and share meaning with others [...] Our culture is now subjectivity and historicity, and is constructed and upheld by the stories we tell and the various discourses that give meaning to our lives” (Kramsch, 2010). While it seems that Kramsch’s definition resonates with language instructors nationwide, often language course descriptions and syllabi, instead of focusing on the idea of critical reflection on a subjective cultural experience, reinforce cultural stereotypes and highlight cultural difference. The reason for this discrepancy seems to lie with the belief that focusing on cultural difference will appeal to large audiences of undergraduates. Do students even consider building intercultural competence to be one of the learning goals of the language classroom?

Motivated by these questions, the study at hand seeks to provide a more nuanced understanding of how students think of the role of culture in the language classroom by conducting a survey and interviews with a limited sample of students taking German Language classes at Cornell. The main research questions we seek to address are:

- How do students think of, experience, and relate to cultural aspects of language in the German language classroom?
- Do students see learning a language (German) as an opportunity to learn ways to negotiate culturally coded content/meaning?
- Do students talk about culture in the classroom strictly in terms of target (German) culture?

## METHODS

*Participants.* The majority of our participants, nine students, were enrolled in first and second semester German language classes at the time our study was conducted. Additionally, we had one student enrolled in a third semester language class and two students enrolled in

an advanced level German language class. Of the twelve student participants: three were first-year students, three were sophomores, four were juniors, one was a senior and one was a second year PhD student. In a short questionnaire on their language use and international experience, students reported using the following languages:

- Interactions with family: English, Korean, Mandarin, German, and Spanish
- Interactions with friends: English, Mandarin, German, and French
- Social media: English, German, and Mandarin
- Work/study: English and French
- Language classroom: German, Spanish, French, and Mandarin

When asked to describe the nature of their international experiences, if any, the participants reported the following:

- International student: 2 students
- Born in German speaking countries: 1 student
- Born abroad: 2 students
- Family/ friends abroad : 9 students
- Study abroad: 2 students
- Travel/ vacation abroad: 8 students
- Internet: 4 students

*Instruments and Procedures.* Participation in this study was voluntary. Individual language instructors presented the study during class time and collected contact information for students who expressed interest in participating. All data for this study was obtained during 30-minute meetings with individual student informants. The meeting was broken down into a Likert scale survey coupled with a brief survey and a semi-structured interview.

The questionnaire listed three questions of which two were focused on collecting background information (“What languages do you use and in what context?” and “Have you had

any international experience? Please describe"). An additional question was asking students to list the first three words that came to mind when thinking about culture. The main purpose of the questionnaire was to collect demographic information. Additionally, the free association question was intended as a preparation for a part of the interview, where participants were asked to elaborate on their initial associations.

The ten items listed on the survey focused on four different areas:

- a. the role of culture in the language classroom
- b. interest in the target culture and motivation to study a language
- c. different tools/factors/facilitators create learning opportunities for learning about culture
  - instructor
  - textbook
  - interactions with peers (group/pair work is an important part of the communicative language classroom)
  - internet
- d. beyond the language classroom
  - on the development of intercultural competence
  - on behavior in every day situations where culture plays a role

The data obtained from the surveys was analyzed quantitatively, looking primarily at distribution of responses and averages.

The bulk of each 30-minute meeting was devoted to a semi-structured interview centered around focal points such as: general perceptions of culture; target culture and motivation for taking a language class; describing and reflecting on instances in the language classroom and beyond where culture played a role; and a discussion of the perceived meaning of concepts such as intercultural, transcultural, and cross-cultural. These interviews have been analyzed with thematic coding.

## SURVEY RESULTS

This section outlines the results of the Likert scale survey (see table below). The results on the first survey question suggest that all participants consider the target culture to play an important role in the language classroom. The second question, which asked participants whether wanting to learn about the target culture significantly influenced their decision to study a language provided a different distribution of responses. While one participant agreed and seven strongly agreed, there was a group of four students for whom the target culture did not constitute an important factor to consider in their decision to learn a language.

When looking at the results for questions 3 through 7 there is noticeable variation in how participants think of the different agents of cultural learning. While 11 out of the 12 students surveyed saw working with realia (original texts/ music/visual material from the target culture) as the main opportunity for learning about the target culture, most participants do not think of classroom conversations with peers as opportunities for learning about culture. Question 5 regarding learning from classroom conversations with peers deliberately included the term "culture" as opposed to "target culture" in order to cover a broader and more diverse spectrum of cultural experience not limited to the cultural sphere of the target language. The fact that 9 of the 12 respondents disagreed or were neutral is all the more interesting given that they were all enrolled in classes with a communicative approach to language, where a significant part of the learning happens during peer and group work.

The distribution of responses to the final three questions on the survey show that a majority of the respondents agreed that taking a language class improved their intercultural competence; however, when the question was posed slightly differently and the buzzword "intercultural" was omitted, one student strongly agreed, six agreed, but four were neutral and one disagreed.

Survey Question	Number of participants who:					Mean	SD
	Strongly disagree	Disagree	Neutral	Agree	Strongly agree		
1) Aspects of the target culture are an important part of the language classroom.	0	0	0	7	5	4.42	0.51
2) Wanting to learn about the target culture played an important role in my decision to study a foreign language.	0	0	4	1	7	4.25	0.97
3) Learning about culture in the language classroom happens when the instructor talks about it.	0	1	5	3	3	3.67	0.98
4) Learning about culture in the language classroom happens when the textbook has a section on culture.	0	1	4	4	3	3.75	0.97
5) Learning about culture in the language classroom happens when I interact with my peers.	0	4	5	3	0	2.92	0.79
6) Learning about culture in the language classroom happens when we talk about original texts/ music/ visual material from the target culture.	0	0	1	3	8	4.58	0.67
7) Learning about culture happens online (on the internet via social media, websites, chat).	0	1	1	7	3	4.00	0.85
8) Taking a language class has improved my intercultural competence.	0	0	1	5	6	4.42	0.67
9) Learning a new language helped me handle complex situations while communicating in the language I use most frequently.	0	3	5	4	0	3.08	0.79
10) Learning a new language has helped me better navigate everyday situations where culture plays a role.	0	1	4	6	1	3.58	0.79

## INTERVIEW RESULTS

While the interviews conducted with the twelve student respondents varied in length and due to their semi-structured nature offered a variety of topics in addition to responses to a set of prepared questions, an analysis of the transcripts allowed me to identify a series of themes.

*The personal connection.* When asked about how they became interested in a particular culture and how they decided to enroll in a particular language class (while most students talked about German, I also encouraged them to talk about experiences with other languages) most student respondents touched upon the topic of a personal, emotional connection. Some respondents had family ties to German speaking countries, and they saw learning about German culture as an avenue to explore family identity and how they as individuals figured into it. Another student, who was born in Germany while his parents were working abroad also discussed his interest in German language and culture as stemming from an exploration of identity. However, identity and family history were only one avenue for relating to a culture. For one of the respondents, taking a language class and learning about German culture was a way of relating to her brothers who had been using German as their secret language.

“My brothers, when they were in high school both studied the German language and German culture and while I went on a different path and studied Spanish, I have always been curious about German language and culture especially since my brothers could speak German and I couldn’t.”

One respondent, excerpted below, expressed the desire to learn a new language and understand a culture was seen as a tool for improving communications with an online friend.

“I was doing a lot of blogging and I met a Polish blogger and her English wasn’t very good and we started talking about a lot of theoretical concepts, about fiction and stuff and I decided that I should learn some

Polish so that I can Skype with my friend, because we would Skype and it wouldn’t be a very fruitful conversation. And so I started learning Polish.”

*Mediated History.* Several students talked about their interest in German history in general, and WWII history in particular, as fueling their interest in German culture. One student reported that his connection to Germany’s WWII history came from books, articles, and documentaries and not from lived memories shared by family members. Even in the absence of family memories, the student talked about how a visit to historical sites in Berlin had been emotionally overwhelming to him as an American.

“I was really excited to go there. I thought it was the place I was most excited to go to on my list, just because I learned so much about the history, and I was such a history nerd about it, so to actually see everything in person, to see the Berlin Wall, the east side gallery... We did a big walking tour, where they took us around and showed us like all kinds of historic sites, whether they were memorialized formally or not. And these were places where all these important historic events happened. It was a very emotional visit for me, as an American.”

Another respondent discussed the influence of German presence in the history of her hometown as something that motivated her interest in German culture.

“Where I was born has lot of German influence. So I came from China and it was a city that was a German colony during WWII and it seems like it wasn’t a nice experience for the city but after the war people did a lot of reflection and turns out that the German influence in the city really changed its appearance and some inner cultural core. I’m not sure if that makes sense. I just think Germany, although it seems very far, has just influenced the environment where I was born.”

The respondent became aware of this history through family memories and high school his-

tory classes.

### *The "Us and Them" Paradigm of Cultural Difference.*

When talking about cultural aspects discussed in the classroom students often resorted to generalizations and stereotypes organized dichotomously. Culture in the classroom seemed to be divided along the lines of "native" (us) and "target" culture (them), both of them identified in connection to ethnicity, nation and rituals.

The following narrative is an example of how the respondents articulated these dichotomies and how they constructed an "us" and a "them." A student respondent narrates an instance in a first semester German language class where the instructor responded to a question on how dating works in Germany:

"We were talking about vocabulary for the family. So we started talking about the words for like a married couple, and then one for two people who are seeing each other, but then we tried to ask the instructor what the word for dating was. And she said that there really isn't one because that is not so much a concept in Germany. Everyone at first was a bit shocked. I mean, we were joking about [the fact] that there wasn't really a concept: 'What, did they just get married? And just start from there? Or do they never get married? Or what exactly happens?' It just seemed very foreign to people. We couldn't imagine that there wasn't a similar dynamic there as there is here."

When asked to discuss an episode in the German language classroom where culture played a role, four different respondents (enrolled in the same class) narrated this very same episode.

*Online Communication.* While in surveys it seemed as if participants regarded the Internet as playing a lesser role in learning language and culture. In the interviews most students mentioned social media, blogging, and the gaming communities as spaces where they learn about culture.

A respondent described her online intercultural experience as follows:

"I was very involved in the gaming community and through the gaming community you can meet a lot of people from different nationalities and different cultures, and while their culture doesn't brightly show through because you are gaming, and you are not really paying attention, there are still moments when you stop and say: "Oh, you do this, oh, I don't do this." So I have friend from Germany that I met on a server for a game and after we connected on Skype to talk, we talked about a bunch of our different experiences, like: he attends a university near Mainz and he talks about how people don't really use cars at least where he lives, and I didn't find that surprising because I knew that but at the same time it is a bit difficult to envision that considering that we are in a country where everyone having a car is the norm."

## FINAL REFLECTIONS

Conducting the survey on a larger group of students would yield more generalizable results. However, I believe that pairing the survey with the interview allowed for more in-depth insights and foregrounded misalignments in the ways students thought they were expected to reflect on certain topics and their actual impressions (see perspectives on the role of the Internet survey and interview).

The survey participants seemed not to be susceptible to terminological differences between "target culture" and "culture" more generally.

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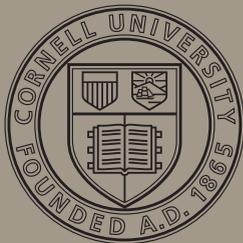
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