

Supplemental Material

CBE—Life Sciences Education

Allison *et al.*

Supplemental Material for Supervised Study: required independent research at a community college supports and persistence in science

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Table S1. Correlation matrix of survey factors for paired data. Pearson correlations for the pre-/post-difference for each pair of factors.

	Project ownership content	Project ownership emotion	Self-efficacy	Identity	Science community values	Networking
Project ownership content	-	0.443	0.350	0.437	0.462	0.240
Project ownership emotion	-	-	-0.073	0.598	-0.014	0.264
Self-efficacy	-	-	-	0.103	-0.015	0.673
Identity	-	-	-	-	-0.111	0.033
Science community values	-	-	-	-	-	0.338

Table S2. Cronbach's alpha assessment of internal consistency across factors and the surveys as a whole.

Cronbach's α	POC	POE	SE	SI	SCV	N	Whole sui
pre-survey	0.93	0.95	0.78	0.82	0.79	0.82	0.94
post-survey	0.84	0.91	0.90	0.89	0.75	0.79	0.93

Table S3. Graduation and transfer outcomes among PITS survey respondents (total n = 34).

	% (n)
Transfer	58.8 (20)
Graduate	82.4 (28)
Graduate & transfer	50.0 (17)

Table S4. Student characteristics among PITS survey respondents (total n = 34).

	Respondents % (n)
Black, Afr. American	9 (3)
Hispanic	12 (4)
White	68 (23)
Other	12 (4)
Under 22	41 (14)
Age 23-39	56 (19)
Age 40 or greater	6 (2)
First generation	29 (10)
Pell received	32 (11)

Table S5. Race and ethnicity among students who transferred, completed a four-year degree.

Category	<u>SCI</u>	<u>sci-LA</u>	<u>sci-GS</u>	<u>TOTAL</u>
# white/Asian transfer students in dataset	104	68	123	295
# non-white/Asian transfer students in dataset	14	13	23	50
% white/Asian in dataset	88.1%	84.0%	84.2%	85.5%
% non-white/Asian in dataset	11.9%	16.0%	15.8%	14.5%
white/Asian bachelors	66	43	62	171
non-white/Asian bachelors	8	7	9	24
% white/Asian bachelors	89.2%	86.0%	87.3%	87.7%
% non-white/Asian bachelors	10.8%	14.0%	12.7%	12.3%
white/Asian SCIENCE majors	40	14	9	63
non-white/Asian SCIENCE majors	5	1	3	9
% white/Asian SCIENCE majors	88.9%	93.3%	75.0%	87.5%
% non-white/Asian SCIENCE majors	11.1%	6.7%	33.3%	12.5%

white/Asian NON-science majors	26	29	53	108
non-white/Asian NON-science majors	3	6	6	15
% white/Asian NON-science majors	89.7	82.9	89.8	87.8
% non-white/Asian NON-science majors	10.3	17.1	10.2	12.2
white/Asian noncompleters	38	14	62	114
non-white/Asian noncompleters	6	6	14	26
% white/Asian noncompleters	86.4	70.0	81.6	81.4
% non-white/Asian noncompleters	13.6	30.0	18.4	18.6

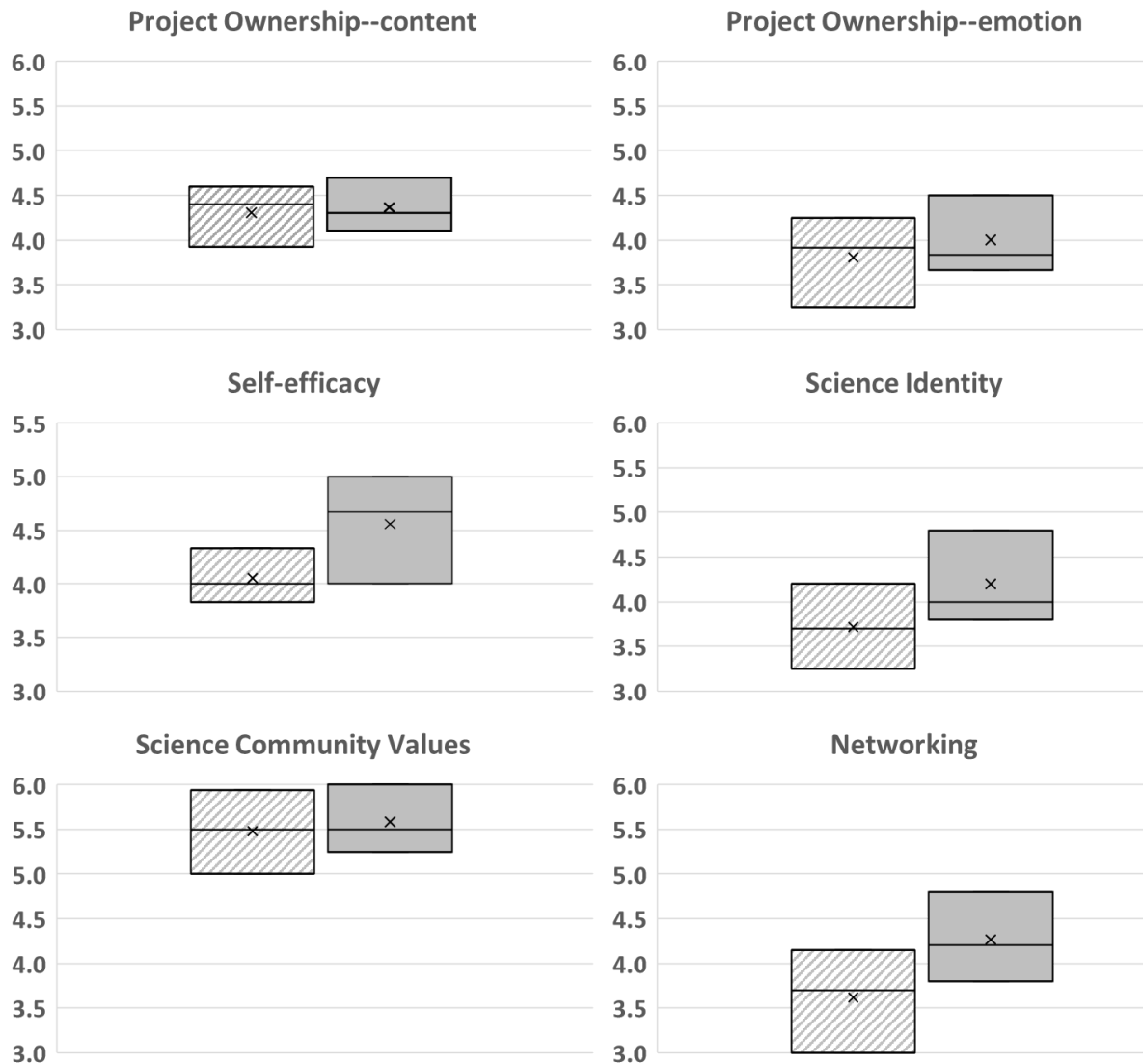


Figure S1. Aggregated pre-post quartile distributions by survey factor. Pre-survey (striped, n=22) and post-survey (solid, n=29) responses shown for six survey factors. Mean (X), median (middle bar), and lower and upper quartiles are shown. Survey factors are on a five-point scale from one (strongly disagree) to five (strongly agree) except Science Community Values which is on a six-point scale from one (not like me at all) to six (very much like me).

Appendix 1: Curriculum sheets for the Science, Liberal Arts, and General Studies Programs at PVCC.

Students in the Science, Liberal Arts, and General Studies degree programs take a similar set of courses as shown in the following curriculum sheets. In this study, students in the Liberal Arts or General Studies programs were identified as “science-oriented” if they had completed the introductory course sequence in biology and/or chemistry (BIO 101 & 102 and/or CHM 111 & 112), representing the closest comparison groups to PVCC Science students with a similar curricular path with the exception of the Supervised Study course. Only Science students are eligible for and required to take Supervised Study.

Physical & Natural Sciences

Associate of Science

Code: 880

Transfer Program

Student Name: _____ Student ID Number: _____

DEVELOPMENTAL COURSES (IF APPLICABLE)	REQUIRED COURSES	COURSE DESCRIPTION	CREDITS	PLAN TO TAKE	GRADE
	SDV 100	College Success Skills	1		
	ENG 111	College Composition I	3		
	ENG 112	College Composition II	3		
	HIS ____	History Elective ⁷	3		
	HIS ____	History Elective ⁷	3		
	MTH ____	Mathematics Elective ⁵	3-5		
	MTH ____	Mathematics Elective ⁵	3-5		
	BIO/CHM/PHY/GOL/ 299	Supervised Study in Science	2		
	CHM 111	College Chemistry I	4		
	CHM 112	College Chemistry II	4		
	_____	Science w/Laboratory Elective ^{1,2,3,4}	4		
	_____	Science w/Laboratory Elective ^{1,2,3,4}	4		
	_____	Mathematics or Science w/Laboratory Elective ¹	4-5		
	_____	Mathematics or Science w/Laboratory Elective ¹	4-5		
	_____	Mathematics or Science w/Laboratory Elective ¹	4-5		
	ITE 119 or CSC 110	Information Literacy or Introduction to Computing	3		
	_____	Humanities Elective ^{5,6}	3		
	_____	Humanities Elective ^{5,6}	3		
	_____	Social Science Elective ⁵	3		

Total Minimum Credits to Complete the A.S. Degree in Science = 61

Liberal Arts
Associate of Arts
 Code: 648
 Transfer Program

Student Name: _____ Student ID Number: _____

DEVELOPMENTAL COURSES (IF APPLICABLE)	REQUIRED COURSES	COURSE DESCRIPTION	CREDITS	PLAN TO TAKE	GRADE
	SDV 100	College Success Skills	1		
	ENG 111	College Composition I	3		
	ENG 112	College Composition II	3		
	ENG ____	Literature Transfer Elective ³	3		
	HIS ____	History Elective ⁶	3		
	HIS ____	History Elective ⁶	3		
	MTH ____	Mathematics Elective ¹	3		
	MTH ____	Mathematics Elective ¹	3		
	____ 101	Foreign Language Elective ²	3-4		
	____ 102	Foreign Language Elective ²	3-4		
	____ 201	Foreign Language Elective ²	3		
	____ 202	Foreign Language Elective ²	3		
	ITE 119/CSC 110/ITE 120	Information Literacy	3		
	HLT/PED	Health or Physical Education Elective	1		
	____	Transfer Elective ⁵	3		
	____	Transfer Elective ⁵	3		
	____	Social Science Elective ¹	3		
	____	Social Science Elective ¹	3		
	Science-oriented students complete BIO 101 & 102 and/or CHM 111&112	Science w/Laboratory Elective ¹	4		
		Science w/Laboratory Elective ¹	4		
		Humanities Elective ^{1,4}	3		

Total Minimum Credits to Complete the A.A. Degree in Liberal Arts = 61 Credits

General Studies
Associate of Science
 Code: 699
 Transfer Program

Student Name: _____ Student ID Number: _____

DEVELOPMENTAL COURSES (IF APPLICABLE)	REQUIRED COURSES	COURSE DESCRIPTION	CREDITS	PLAN TO TAKE	GRADE
	SDV 100	College Success Skills	1		
	ENG 111	College Composition I	3		
	ENG 112	College Composition II	3		
	HIS ____	History Elective ⁵	3		
	HIS ____	History Elective ⁵	3		
	CST 100	Principles of Public Speaking	3		
	ITE 119 or ITE 120 or CSC 110	Information Literacy or Principles of Information Systems or Introduction to Computing	3		
	HUM ____	Humanities Core Course ³	3		
	HUM ____	Humanities Core Course ³	3		
	ENG ____	Literature Transfer Elective ⁴	3		
	MTH ____	Mathematics Elective ¹	3		
	MTH ____ or	Mathematics Elective or Transfer Elective	3		
	Science-oriented students complete BIO 101 & 102 and/or CHM 111&112	Science w/Laboratory Elective ¹	4		
		Science w/Laboratory Elective ¹	4		
	_____	Social Science Elective	3		
	_____	Social Science Elective ¹	3		
	_____	Social Science Elective ¹ or Transfer Elective ²	3		
	_____	Transfer Elective ²	3		
	_____	Transfer Elective ²	3		
	_____	Transfer Elective ²	3		
	_____	Transfer Elective ²	3		

Total Minimum Credits to Complete the A.S. Degree in General Studies = 63

Appendix 2: PVCC Science Program Student Learning Outcomes and Assessments

<p>PVCC Science Program</p> <p>Student Learning Outcome</p>	<p>Assessment Results Summary</p>
<p>SLO 1: Apply Scientific Knowledge in Everyday Life</p>	<p>Supervised Study proposal requires student to articulate rational for the project to real life</p>
<p>SLO 2: Apply Specific Math Concepts</p>	<p>In Supervised Study, students must identify and use appropriate statistical analysis</p>
<p>SLO 3: Basic Lab Safety Procedures</p>	<p>Supervised Study research involves safety training, planning, and application of relevant safety measures in data collection</p>
<p>SLO 4: Integrate Scientific Principles</p>	<p>Demonstrated in Supervised Study proposal and independent research project</p>
<p>SLO 5: Demonstrate knowledge of Basic Scientific Principles</p>	<p>Final exams and lab tests/projects in all lab science and Supervised Study courses</p>
<p>SLO 6: Organize and Communicate Scientific Data</p>	<p>Construct poster identifying all elements of scientific method including a written discussion and summary sections and then present this process orally during a formal poster presentation</p>
<p>SLO 7: Scientific Inquiry</p>	<p>Demonstrated in Supervised Study research</p>
<p>SLO 8: Work as a Member of a Scientific Team</p>	<p>Demonstrated in Supervised Study learning community</p>

Appendix 3: Supervised Study Syllabus (Fall 2021)

Note: a living document that is updated regularly can be viewed at <https://doi.org/10.17605/OSF.IO/3XSCM>

Science 299 Supervised Study Syllabus Fall 2021

(PHY-, BIO-, CHM-, GOL-299)

Fridays 12:00-12:50pm

Keats Rm. 209

Welcome

Welcome to Science 299! This 2-credit capstone course is required for the Associates degree in Science at PVCC. In this course, you will use the knowledge and skills you have learned throughout the Science program to design and conduct your own research project. You will communicate weekly with a faculty mentor in your area of academic interest (geology, chemistry, biology, or physics). Those of you doing projects in biology or chemistry will also be paired with a lab manager who will offer some guidance in the lab. At the beginning of the semester, you will write and revise a project proposal. At the end of the semester, you will write an abstract and create a poster that you will present at a scientific poster session open to the PVCC community and the public. The opportunity to do your own research early in your college career is somewhat rare, whether one is at a community college or a four-year institution. Students who have taken this course report that it helped them with transfer, jobs, personal skills such as time management, and more. You will have a chance to interact with a couple recent Science 299 alumni this semester, and we hope you will keep in touch with the sciences at PVCC when you graduate!

Contact Information

Course Coordinators & Instructors: Professor A & Professor B

Email: _____ & _____

Division: Health and Life Sciences & Business, Mathematics & Technology

*Please contact Dr. _____ with questions about course logistics, policies, etc.

When you have specific questions about your project, it is best to contact your faculty mentor. More general questions about writing proposals, managing your research, making a scientific poster, etc. can be put to the course coordinators and/or your faculty mentor.

Instructor Availability

Dr. _____:

Monday 2:00-4:00pm (in person)

Tuesday 12:00-1:00pm (via Zoom); 1:00-2:00pm (in K205: lab);

5:00-6:00pm (via Zoom)

Wednesday 2:00-4:00pm (in person)

Friday 11:00am-12:00pm (via Zoom)

*Zoom office hours will be held in my personal Zoom meeting room and the link to this will be provided on Canvas. In person office hours are in _____.

Dr. _____:

Tuesday/Thursday 11:30 am - 12:30 pm, 3:15 pm – 4:00 pm (in person);

Wednesday 11:30 am - 2:00 pm (in person);

Fri 10:00 am – noon (via Zoom by appointment) .

*Zoom office hours will be held in my personal Zoom meeting room and the link to this will be provided on Canvas. In person office hours are in _____:

Communication and Response Time:

Email is the best way to communicate with us. You are required to use your assigned VCCS email address for all electronic communications. When you e-mail me, please use a proper reference in the “subject” field, detail which course you are enrolled in and sign your name at the bottom of the email. I will respond to emails within 48 hours. Office hours are posted above. My personal “Zoom room” will be used for some of my office hours. The link to this Zoom room can be found on your Canvas site. Appointments are available upon request.

Course Description

To complete this course successfully, a student must demonstrate independent and critical thinking skills through application of the scientific method. Students will select a subject to investigate in cooperation with a faculty mentor, formulate a hypothesis, perform experiments to test the hypothesis, and draw conclusions about the hypothesis. The student is expected to create a poster that describes their project and to present this poster at an end-of-semester seminar. As part of poster production, each student will

create a set of slides of the poster to be archived at PVCC. Each student is expected to consult with the appropriate PVCC lab personnel in a timely manner to order materials and discuss safety issues concerning their experiments.

Course Learning Objectives

As a capstone course, Science 299 is designed to allow students to use all the skills and knowledge they have gained throughout the PVCC Science Program. In Science 299, students will demonstrate:

- independent and critical thinking through the design, execution, and analysis of a research project using appropriate scientific theory and methodology
- a thorough understanding of the applications and basic principles of the instrumentation and/or software vital to their research projects
- the ability to effectively communicate their research ideas and findings both orally and in writing
- a thorough understanding of the scientific principles related to their area of research

Course Purpose, Knowledge, Attitude, and Skills

Purpose: Our goal in this course is to offer structure and guidance as you design, conduct, analyze, and present your own research project. This capstone experience allows you to practice scientific techniques and apply knowledge that you learned in previous courses. In Science 299, you will use every step of the scientific process in a complete research cycle. While you work independently, you are part of a research community where you can give and receive feedback and share ideas. We want Science 299 to inform and have a great impact on your academic and professional journey.

Knowledge: You will gain expertise in your project area. By the middle of the semester, you will more know more about your topic than anyone else in the class. You will make connections with previous courses in your discipline and solidify some content of your discipline. You will develop your understanding of the scientific process. You will know what scholarly work feels like firsthand.

Attitude/ability: In Science 299 you are likely going to gain confidence, develop science identity, be creative, and become more resourceful, tenacious, assertive.

Skills: In Science 299, you will learn to think like a scientist by choosing methodology, reframing problems, and learning what you don't know. Since research rarely unfolds as expected, you will likely become more comfortable with failure and rebounding. This humbling experience can also be very exciting as you realize the contours of what is/isn't known in your area of research. You will refine managing time and priorities. You will gain project management skills. Broadly speaking, you will develop a group of transferable skills including building relationships with peers and faculty, honing observation skills, and communicating with diverse audiences.

Required Textbook(s) and Course Materials

For this course, you will need a way of keeping organized lab notes (a notebook or a computer). PVCC will provide materials as determined by your approved research plans as well as a professional printed poster for students who submit their poster files on time.

Course Website:

Course documents can be found on the course Canvas site. In the event that I need to contact you outside of normal class times, I will send announcements via the Canvas site. Please check the site regularly. Students are responsible for the information contained on the Canvas site.

We recently created a Science 299 website. Some past projects can be viewed here:

<https://sites.google.com/view/science299research/home>

General grading criteria:

- A. Originality of the project
- B. Amount of effort required to carry out the project
- C. Difficulty of the project
- D. Completion and timeliness of assignment submissions (see due dates in schedule below)
 - Project proposal
 - Presentation abstract
 - Poster
 - Other assignments as required by mentor
- E. Poster presentation:
 - Clarity of poster information
 - Completeness of poster information
 - Visual appeal of poster
 - Ability to present poster to others
- F. Other criteria as determined by your advisor

Specific grading criteria:

1. Proposal (20% of Course Grade: 15% for final proposal/5% for draft): The proposal should be feasible, logical, well-researched using primary peer-reviewed references, well-reasoned (demonstrate clear understanding of background and where your project fits into existing literature). It should include a thorough methods section with specific protocols that will be used and a list of supplies that indicates what is available at PVCC and what needs to be ordered. Students will write a complete draft of their proposal in which their faculty mentor will provide feedback. Drafts will be graded based on completeness of all sections and submission by the deadline. Students are then to

consider mentor feedback and make edits and submit a final version of their proposal. See proposal information sheet and rubric on our Canvas site and due dates in the schedule below.

2. Abstract (10% of Course Grade: 5% for final abstract/5% for draft): Each abstract will be included in an abstract booklet to be made available on the day of the seminar. One of our group meetings will include information about writing an effective abstract and resources will be available on our Canvas site. Students will write a draft of their abstract in which their faculty mentor will provide feedback. Drafts will be graded based on completeness and submission by the deadline. Students are then to consider mentor feedback and make edits and submit a final version of their abstract. See submission date on the schedule below.
3. Poster (15% of Course Grade: 10% for final poster/5% for draft): Posters should be polished and complete with legible text, tables and figures including titles, labels and captions that allow the poster to stand on its own (i.e. someone with a strong general science background should be able to read your poster without your assistance and understand what your research was about and what you found). For more information on poster construction see available resources on our Canvas page. One of our group meetings will be about constructing an effective poster. A draft must be submitted to your mentor with enough time (see course schedule) for you to print a revised version before the poster session – allow additional 3-5 business days for the printing process. Drafts will be graded on completeness of all sections and submission by the deadline.
4. Poster presentation (10% of Course Grade): Professional attire and behavior are expected. You will be judged on clarity of presentation, how well you answer questions from seminar visitors, and the reports of other science faculty who observe your work.
5. Research (45% of Course Grade: 40% for research conducted, 5% for written mid-term progress report): You will be graded on originality, level of difficulty, regular progress, ingenuity, problem solving, creativity, dedication, and timely communication with your faculty advisor.

Course Policies

- The official class meeting time is Fridays from noon – 12:50. Missing a required class meeting will result in a course grade penalty of up to 10%. Missing more than one required class meeting may result in withdrawal from the course.
- Failure to submit an acceptable proposal by the due date, will result in immediate withdrawal from the course.
- Research mentors are prohibited from offering extensions on submission deadlines. Extensions can only be granted by course coordinators.
- Late submission of drafts or final versions the work listed above may be subject to a 15% deduction of your grade for that assignment.

- Presentation of your research is an important piece of this learning experience. To earn a grade higher than C you must create a poster and partake in the poster session.
- This independent research project is required for graduation. If you do not complete the work associated with this project, you will not be able to graduate with an AS degree in Science from PVCC.
- When you require lab time, the hours you plan to work must be arranged with the associated instructor and/or lab manager. Students are not allowed to work in the labs alone. It is expected for students to respect the busy schedules of both faculty advisors and lab personnel. If you arrange to arrive at a specific time, you should do so. It is possible that students who are late and/or do not appear, will lose the scheduled lab time. Contact your advisor and lab manager if the time you have scheduled changes or if you will be late.
- It is the student's responsibility to clean up the lab space after the completion of their research.
- Once a grade has been made available to students, students have one week to appeal that grade. To appeal an entire course grade, please refer to PVCC policies.

Course Schedule: All meetings on the schedule shown below are required. Fridays in which the class cannot meet can be used to work on your research, meet with your mentor, or meet with the coordinators.

DATE (Fridays)	Required class meetings In K209 (12:00-12:50pm)	Description	Student Due Dates	Faculty Feedback Due Dates
08/27/21	Welcome, introductions, course structure, meet with faculty mentor	Faculty led: students will be matched with faculty mentors, then students will meet with faculty mentors and narrow project ideas		

09/03/21	Alumni visit, short summaries of project ideas, safety training	Student led: hear from a previous 299 student about the research process. Think about questions you may have!	One-paragraph outline of your project to your faculty mentor via email by start of class.	
09/10/21	Share proposal topics with group: 3-4 minute talk about plans	Student led: students share their project ideas and approach and make suggestions to peers	Proposal draft due on Canvas by start of class.	Proposal feedback due to students no later than Tuesday 09/14/21 at 5pm
09/17/21	No class	Work on project & reach out if needed!	Finished proposal due on Canvas by start of class.	
09/24/21	No class	Work on project & reach out if needed!		
10/01/21	How to incorporate data analysis and appropriate statistics into your research design	Faculty led: What are statistics & why are they important. What options are there?	Submit blank data table on Canvas that shows how you will collect and organize data by start of class	
10/08/21	No class	Work on project & reach out if needed!		

10/15/21	No class	Are you collecting data on your project yet (you should be!)?		
10/22/21	Project updates – oral presentation to class, written summary	Student led: Students will provide their peers with an update on their progress, issues they encountered, and provide feedback to others.	Written Mid-term report due on Canvas by start of class	
10/29/21	No class	Work on project & reach out if needed!		
11/05/21	No class	Work on project & reach out if needed!		
11/12/21	How to design a presentation; alumni visit	Hear from a previous 299 student about presenting their research. Come with questions!		
11/19/21	No class	Work on presentation & reach out if needed!	Draft of poster due by 12pm on Friday 11/19	Poster feedback due to students no later than Tuesday 11/23/21 at 5pm

11/26/21	Thanksgiving: No class	Work on presentation & reach out if needed!		
12/03/21	Poster presentation practice	Student led: Students will practice presenting their posters to 1 other student and 1-2 faculty members. *please bring your computer with your poster on it*	Final poster & abstract drafts due by start of class	Abstract feedback due to students no later than Sunday 12/05/21 at 5pm
12/10/21	Poster Session 11:30am – 1:30pm North Mall Meeting Room		NOTE: Abstract due Tuesday 12/07/21 at 12pm!	