**Online Appendix**

**Syllabus and Course Notes**

**KEYSTONE 115-15**

**J-Term Research Experience: “Science Bootcamp”**

**Tuesday-Fridays: 9:30am – 1:00pm Schaible Science Center Room 120 (Illinois Hall)**

**Instructors**

Instructor Information Blinded for Submission

**Office Hours**

Tuesdays-Fridays immediately following class and by appointment

**Prerequisite**

First year and STEM Major

**Course Description**

This course is part of the first-year experience for students interested in STEM majors (Biology, Chemistry, Mathematics, Exercise Science, Physics, Psychology, and Computer Science). The course involves an introduction to research and applied projects within the discipline of interest. Students who are interested in applying for summer research in the KEYSTONE program must take this course.

Although there will be lectures from the instructors, the majority of the course meeting times, as well as efforts beyond the scheduled class time, will be working in groups on the respective research projects. The last day of the course will be dedicated to student presentations of projects and research results.

**Science Bootcamp Experience Learning Outcomes**

By the end of the course, students will be able to:

1. demonstrate an understanding of the research process within and across the STEM disciplines;
2. demonstrate an understanding of the collaborative nature of research within and across the STEM disciplines;
3. develop a research topic/project, implement a research/project plan, write-up and communicate results.

**Major Tasks**

Students will:

1) engage in the process of scientific research

2) write a scientific paper

3) orally present study ideas (oral proposal) and study results (research poster)

**Grading**

The final course grade will be calculated based on the following points:

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| --- | --- |
| **Course Component** | **Possible Points** |
| 1) Class Participation & Peer Evaluation | 40 |
| 2) Research Project: Process Points  Find 1 Article Assignment (5)  Find 2 Articles Assignment (5)  Oral Research Project Proposal (with group) (15)  Written Research Project Proposal (with group) (25)  Journal Articles Summaries/Critique (10)  Introduction Draft (15)  Introduction Revision (10)  Method/Materials Draft (10)  Method/Materials Revision (10)  Results/Discussion Draft (15) | 120 |
| 3) Research Project: Poster (with group) | 20 |
| 4) Research Project: Final Paper | 100 |
| **TOTAL AVAILABLE POINTS** | **280** |

Letter grades will be assigned as follows:

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| **Grade** | | **Percentage** |
|  | A | ≥ 93 |
|  | A- | 90-92 |
|  | B+ | 87-89 |
|  | B | 83-86 |
|  | B- | 80-82 |
|  | C+ | 77-79 |
|  | C | 73-76 |
|  | C- | 70-72 |
|  | D | 60-69 |
|  | F | < 60 |

**HONORS STUDENTS**

If you are receiving Honors Credit for this course, you have one additional requirement:

1) One public presentation of

your research project.

More details to follow!

**Course Policies**

**Participation & Attendance**

* Class begins each day at 9:30 a.m. It is expected that you will arrive on time and attend class all classes
* If you must miss class due to an emergency (an excused absence), please let us know (phone or email) *before* the start of class.
* It is your responsibility to keep informed regarding lecture content, new assignments, and any missed work by utilizing email and/or reading Blackboard announcements.
* If you have an excused absence, then any assignments must be submitted as soon as possible and before the next class you are able to attend.
* If you must miss any class meetings or class-related activities due to a school-related activity, then you must provide a schedule from a coach, director, or faculty member as early as possible during the term and must submit assignments due for that class meeting before it is due.

**Assignments**

* Each assignment MUST be submitted at the START of the class period; otherwise the assignment will be considered late. Late assignments will have 25% deducted for each DAY (not class meeting) late. Late assignments will not be accepted after two days.
* Missed work will result in receiving 0 points for the assignment. Exceptional circumstances should be discussed with the instructor in advance.
* All written assignments must be typed in 12pt font and printed on 8.5x11’’ paper.
* Written assignments must be stapled together in order and must have page numbers. Double-sided is fine. Please submit 2 copies for peer review and 2 copies for revisions, if requested.
* Final papers will be submitted electronically and must be named according to the assignment specifications.
* Unless it is specifically a group assignment, your work must be your own. Cheating and plagiarism will result in 0 points for the applicable assignment, and, after further disciplinary action, there will be a possibility of earning a failing grade (“F”) for the entire course. See Student Code of Conduct/Civility Section in this Syllabus.

**Appropriate Use of Course Materials**

The materials distributed in this course and on Blackboard, including, but not limited to, syllabi, assignment instructions, lecture slides, and lecture recordings are protected by copyright and provided solely for the educational use of students enrolled in this course. Distribution of course materials for purposes unapproved by the instructor is not permitted. In particular, you are not permitted to post course materials on commercial websites (sharing notes with your fellow students in this class is fine). The sharing of class materials without the specific, documented approval of the instructor may be a violation of the Elmhurst College Student Handbook and an act of academic dishonesty, which could result in further disciplinary action.

**Student Code of Conduct/Civility**

* Full details of code of conduct/civility may be obtained from the Student Handbook, called E-Book.
* At a minimum students and faculty should treat each other politely and with respect.
* Unless given permission by an instructor, while class is session you may not use laptops, classroom computers, smart phones, recording devices to execute activities such as, but not limited to answering email, updating social networking pages (e.g. Facebook), surfing the web for pages not related to class, instant messaging and playing computer games.
* Please remember that personal conversation during lecture and lab time is distracting to your fellow students and therefore is inappropriate.
* It is permissible to discuss homework and project specifications with classmates or to hold study groups to help grasp the concepts. However, you are to do your own work.
* Copying a software project (via any software commands), a homework assignment, experimental data, homework solutions, or downloading solutions or research papers from the Internet is tantamount to a failing grade for the course. Also, for more details on cheating and plagiarism and related subjects, see the E-book Section called Code of Academic Integrity.

**Student Preparation**

* Science is a process and this is your chance to DO science! Be engaged and participate! The more you put into this class, the more you will get out of it!
* Get sleep and get to class on time.
* When possible browse any online course materials relevant to lectures before and after lectures.
* Be proactive in communicating with your professors and fellow classmates; ask for help and then take action on implementing their advice.

**Mental Health and Stress Management**

As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance and may reduce your ability to participate in daily activities. Elmhurst College services are available to assist you. You can learn more about the confidential mental health services available at the Elmhurst College Wellness Center, (630) 617-3565 (http://www.elmhurst.edu/wellness/1316887.html).

In the event we suspect you need support, we will express our concerns and the reasons for them, and remind you of resources that might be helpful to you. It is not our intention to know the details of what might be bothering you, but simply to let you know we are concerned and that help, if needed, is available.

Getting help is a smart and courageous thing to do -- for yourself *and*for those who care about you!

**Access and Disability Services**

We are committed to supporting the learning of all students in this course. Elmhurst College will make reasonable accommodations for students with disabilities based on the presentation of appropriate documentation. If you believe that you have a disability that may impact your work in this course, contact Linda Harrell, ADS Coordinator, at disability.services@elmhurst.edu or 630-617-6448. The ADS office is located on the main floor of the A.C. Buehler Library. Classroom accommodations must be renewed each term. Once you have your letter of accommodations, please meet with us early in the term to discuss, plan, and implement your accommodations in the course.

**Learning Center - Academic Support**

The Learning Center offers services to support the academic performance of all Elmhurst College students. Sessions are structured to promote principles of self-regulated learning and academic management. Areas of peer tutoring include math, statistics, writing, biology, kinesiology, psychology and political science. Additionally, assistance with special test preparation (e.g., ACT, SAT, GRE, and TAP) and academic reading/study strategies is available. For more information, contact Emmi McAdams, Tutoring Coordinator, at emmim@elmhurst.edu, 630-617-5376, or Susan Roach, Learning Center Director, at susan.roach@elmhurst.edu, 630-617-3155. The Learning Center is located on the main floor of the library.

**Notes**

**TENTATIVE SCHEDULE**

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| **WEEK 1** | | |
| **Date** | **Topic** | **Due In Class** |
| Tues  1/7 | “Experimental Test” & Discussion  What is Science?  Meet & Greet  Syllabus Overview | ☺ |
| Wed  1/8 | How to Read Journal Articles (Discuss Paper #1)  How do Develop Research Ideas  How to Search for Articles  Group Formation & Project Brainstorming! | * Read Paper #1 and come ready to discuss! (bring hard copy) |
| Thurs  1/9 | How to Design Experiments (Discuss Paper #2)  Share Articles with Groups & Class  Overview of Written & Oral Proposal Assignments  Project Brainstorming & Search for 2 Articles | * Read Paper #2 & come to class ready to discuss! (bring hard copy) * Find & read 1 peer-reviewed journal article (bring hard copy) (5) |
| Friday  1/10 | Share Articles with Groups  More Project Brainstorming & Begin Developing Design  Group Meetings with Dr. Guenther & Dr. Majka | * Find & read 2 peer-reviewed journal articles (bring hard copies) (5) |

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| **WEEK 2** | | |
| **Date** | **Topic** | **Due In Class** |
| Tues  1/14 | Finalize Designs!  Prep Oral Presentations (proposal) | ☺ (Read articles, communicate with  group about project ideas) |
| Wed 1/15 | Oral Presentations & Discussion | * Oral Proposal Slides (15) |
| Thurs 1/16 | Finish Oral Presentations (if necessary)  Work on Written Proposals  Start Working on Projects!  (work to finalize equipment list, develop stimuli, etc.) | ☺ |
| Friday 1/17 | Overview: Writing Introductions  Work on Projects! | * Written Proposal (25) * Summaries (due 11:59 p.m.) (10) |
| **WEEK 3** | | | |
| **Date** | **Topic** | **Due In Class** | |
| Tues  1/21 | Introduction Draft Peer Review/Discussion  Work on Projects! | * Introduction Draft (15) | |
| Wed  1/22 | Overview: Writing Materials/Methods  Work on Projects! | * Revised Introduction (10) | |
| Thurs 1/23 | Materials/Method Draft Peer Review/Discussion  Stats Review  Work on Projects! | * Method/Materials Draft (10) | |
| Friday  1/24 | Overview: Writing Results & Discussion  Data Analysis!  Work on Projects! | * Method/Materials Revision (10) * Have All Data Collected! | |

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| **WEEK 4** | | |
| **Date** | **Topic** | **Due In Class** |
| Tues  1/28 | Research Project: Results/Discussion Draft Peer Review/Discussion  Overview: Posters  Work on Posters | * Results/Discussion Draft (15) |
| Wed 1/29 | Finish Poster!  Final Paper Q & A  Overview: Future Research Opportunities  Open Meetings with Dr. Guenther & Dr. Majka | * Final Poster (due 11:59 p.m.) (20) |
| Thurs 1/30 | Finish Paper!  Practice Poster Presentation  Open Meetings with Dr. Guenther & Dr. Majka | * Final Paper (due 11:59 pm) (100) |
| Friday 1/31 | Poster Presentations  Course Wrap-Up! | ☺ |

**Detailed Class Notes Describing Class Schedule and Activities**

*Note.* All class materials are available via email from the first author.

**Week 1: Setting the Stage**

**Day 1.** The goal of Week 1 is to set the stage for the communal vibe of the class and to give students practice with skills that will help them design and carry out their independent projects. Day 1 begins very deliberately with a class activity and ends with an overview of the syllabus. The activity is a knock-off of the “Pepsi-Coke Challenge” with some notable confounds introduced. The instructors invite students to take part in a very “official, scientific taste test” of Soda X and Soda Y. Two students are invited to come up and serve as bartenders and are asked to pour samples for their classmates. They are presented with a table of randomly assorted cups in various sizes, colors, and materials. Students are asked to come sample each soda in front of the entire class and then to vote publicly for which soda they prefer, with answers tallied on the blackboard. As the students come up and taste the drinks, it quickly becomes apparent that that this “official” experiment is not so official. One of the experimenters (an instructor) publicly comments on each choice saying things like “good choice!”, “yes”! Soda X is repeatedly introduced as “Delicious Soda X” in an upbeat voice while Soda Y is announced in a monotone fashion. Quickly Soda X emerges as the clear preference? In short, the entire “experiment” is rigged in numerous ways to be terrible! Most notably, Soda X is cold and bubbly Coke, while Soda Y is a warm, diluted, and de-carbonated version of a generic diet soda.

What follows from the activity is a very natural student-driven discussion about the problems with the study. The instructors then ask the students more formally to brainstorm how to improve the study. Students are asked to generate ideas in small groups and then share with the entire class. Quickly, a clean version of the study emerges, one free of confounds and full of good controls like “hold temperature constant”, “systematically vary the taste order”, “pour the same amount in the same kinds of cups”, etc. Thus the student students very naturally design a study in which they manipulate only their variable of choice, holding constant all other factors.

After the class activity, the instructors lead a discussion surrounding the question “What is science”? Meant to be more rhetorical and generate discussion, the instructors show a number of models of the “scientific method”. All are copied from a quick internet search of the term “scientific method” and some are quite “official”, from various science textbooks, while others are more cartoonish (including one demonstrating how babies follow the scientific method). The students, all STEM students who have had experience and an interest in science, are all able to articulate the key components of the models. But they are also quick to point out differences in the model. Typically one student will point out how some of the models have arrows going only in one direction, as if science occurs in a linear fashion. Another student typically points out a preference for the more “cyclical” models, where the “starting” point of an experiment can be anywhere (e.g., with an observation or with data).

The final activity of Day 1 is a research “classmate meet and greet”. Students are given upward of an hour to mingle and meet their classmates. They are instructed to talk with everyone and to focus on what topics excite them. Their goal is to be able to identify, by name, 4 students that they would be interested in working with on a group project. Thus, the students are motivated to learn other students’ majors, what courses they’ve taken, what topics they are interested in, etc. The instructors mingle as well, trying to get quieter students to open up, and commenting on students’ conversations (e.g., wow, although you are interested in biology and you are interested in psychology, it sounds like you both have interests in issues of sustainability). The instructors conclude Day 1 with a discussion of the syllabus. Each page is discussed and the emphasis on “process” is articulated several times. By the end of Day 1, students (and faculty!) typically leave the class energized and excited for Day 2!

The homework for the first night of class is for students to read an empirical journal article—many students’ first journal article. Little instruction is given other than “to read the paper for tomorrow and come ready to discuss”. The past few years the instructors have chosen a psychology two-page page “flash report” article in a flagship journal (Psychological Science) that investigates people’s abilities to accurately discriminate between real and fake smiles following social exclusion (Bernstein et al., 2008). The article is short, relatively jargon free, includes all key components of an empirical paper (intro, method, results, discussion), contains simple statistics (one-way ANOVA), and includes a graph. Thus it is an article students don’t find too overwhelming, and one that students find interesting (as evidenced by their discussion the following day—they come with questions and ideas for future research).

**Day 2.** Day 2 focuses on how to read journal articles, with the homework paper used as a model, and students are also taught how to find journal articles using various databases. They also learn about the peer review process and how to find full-text articles (including using Google Scholar, visiting author websites, etc.). While discussing the homework articles, the instructors lead a discussion of how to generate research ideas. Students are naturally led into the discussion because they generally start to raise concerns with the paper (sometimes this requires a little nudging). These concerns, in turn, are shaped into research questions and ideas for how to “fix” issues. For example, students might point out a small sample size and the solution offered is to collect data from a larger, more representative sample. Students might also take issue with how a construct was manipulated or measured and offer solutions. This discussion is bulleted on the board, enabling the instructors to highlight themes for how research ideas are generated in science. An emphasis is placed on studies filling some kind of “gap” in our knowledge, thereby offering a novel solution.

Equipped with the skills of finding articles and generating research ideas, students are then introduced to their groups. Rather than allowing students to select groups, the instructors create the groups based, in part, on student preferences indicated on the handout following the research “meet and greet” on Day 1. Instructors do their best to separate students who have strong relationships (since one of the goals of the course is for students to broaden their social network of science peers). Efforts are made to compose groups that contain both stronger and weaker students (based on fall semester grades and instructor knowledge of student performance in their fall classes), as well as students who are more and less extroverted and/or have leadership potential. Some years the groups trend toward being more interdisciplinary and some years they trend toward being discipline-focused (e.g., a chemistry group, a psychology group). Oftentimes, math, physics, and computer science students are the numerical minority and are “folded” into other groups. These students tend to be strong in data analysis and basic computer programming, so are generally nice additions to any group.

During the last hour of Day 2, students are given time to get to know their group members, exchange contact information, and start to brainstorm project ideas. Their homework for the evening is to read one additional empirical article with the entire class (a biology focused paper) and also to find and skim an empirical paper related to a topic they find interesting and potentially useful for their group project.

**Day 3.** Day 3 begins with a class discussion of the second class article, which is a biology focused empirical paper with “complex” methods (Allan et al., 2003). It is a much tougher read for students, but still within their capabilities if they spend some time with the paper. The biology instructor takes the lead on breaking downs some of the jargon to reveal a relatively simply paper. The article discussion launches into a mini-lecture on how to design experiments. References are made to the “Pepsi/Coke” challenge on Day 1, where students revealed their intuitive understanding of many elements of experimental design.

Next, students break into their research groups and each student shares the gist of the empirical article they found and skimmed for class. Groups are given time to narrow their interests and are told the task for the next day of class is to find 2 more articles—ideally with everyone in the group finding a paper related in some way to the group’s theme. Students also learn more formally what the group project is. They learn they will be conducting an experiment and will need to draft a formal manuscript and poster of their findings. To scaffold this process, they learn about the first two assignments: the oral proposal and the written proposal. Both follow similar formats, but the oral proposal is delivered to the class first to garner feedback that can be incorporated into the written proposal.

**Day 4**. Day 4 of the class, the last day of Week 1, is reserved for a long group meeting. Each group member shares the 2 articles they brought to class and the groups are tasked with really trying to narrow their research interests, trying to find a “gap” in the literature that they could address through a tractable experiment. The instructors allow the students a solid 45 minutes or so to discuss before walking around and listening in and offering suggestions, particularly with ideas about how to transfer an idea into an experiment. Students’ homework over the long weekend (since class only meets Tuesday-Friday) is to continue finding and reading articles and communicating with their group members to narrow their research idea.

**Week 2: Design Study**

**Day 1.** The primary goal of the 2nd week of class is for students to finalize their research design. Day 1 of the week they are given time to chat about articles they read over the weekend and to start prepping slides for their oral presentations, which begin on Wednesday. Both Instructors provide feedback to each group.

**Day 2.** The oral presentations offer the students the opportunity to orally share their project ideas with their classmates and several science faculty members to get as much feedback as possible. Typically, a few extra faculty members are invited (from a variety of disciplines) to hear the students’ “pitches”. The oral presentation sections include: A group name, a working title, a clear hypothesis (in one sentence), background/justification for the hypothesis, proposed method, predicted results (including a graph), potential implications of findings, and references. It is required that each group member speak and that slides are used to support the presentation. Before the groups begin, the instructors remind the entire class to be constructive in their critiques and they also warn students that their projects will likely shift after orally presenting and getting feedback—which is the point! The entire oral presentation process is meant to mimic a “lab meeting” in graduate school, as one component of the scientific community. Aside from getting feedback from their classmates, students observe all their classmates presenting, thereby learning from the feedback shared across all presentations. This process, in and of itself, helps students better understand how to set up and justify a study.

**Day 3.** After the oral presentations—which are generally high energy and fun time for all—students get back into their groups and refine their ideas in light of the feedback they received from their classmates and the faculty. This often involves them returning to the literature and doing additional reading. They then transfer their ideas into a written proposal, which follows the same format as the oral presentation. They work together as a group, submitting one assignment.

**Day 4.** On the last day of Week 2, the instructors begin the process of describing how to write an empirical manuscript, starting with the introduction. By this point, the students are familiar with each section of an empirical paper, but they can better appreciate specific instruction in how to write since they have a solid understanding of their research design. The instructors describe the key components of the introduction as an opening (an opportunity to draw the reader in and introduce the research questions), a literature review (an overview of the essential literature required to understand the research design), the “gap” (an identification of the novelty of the project and the justification), study overview (brief overview of the methods), and hypotheses. Students are also taught how to cite references in text using APA style and how to format a reference list. After learning how to write an introduction, students are tasked with writing the introduction to their own research design over the long weekend. Over the weekend the instructors workshop the written proposals, giving students feedback to incorporate into their design. The two primary criteria for evaluating the proposals are feasibility and grounding in the literature, with the understanding that an exhaustive literature review is unreasonable for 1st year students in such a short time frame. Students typically cite 5-7 papers throughout the entire manuscript.

**Week 3: Conduct Study & Begin Writing**

The primary goals of Week 3 are to conduct the experiments and to continue learning how to write an empirical manuscript. Thus Week 3 is a busy one! Many students need to learn methods to even conduct their experiments. For example, biology-themed groups may need to learn how to plate bacteria, psychology-focused groups need to learn how to program online studies or carry out face-to-face lab studies, and so forth. As a result, the week involves a lot of trial and error before the students are actually able to collect their “real” data. The faculty assist wholeheartedly and sometimes biology personnel and other faculty (outside the expertise of the main instructors) may also step in to help out. The instructors do their best to maintain an upbeat and optimistic vibe, stressing the process of conducting the experiment rather than the outcome. Ideally groups have their final data collected by the last day (Friday) of Week 3, but in some cases students need the weekend.

Once data are collected, groups meet with the instructors to learn how to enter and analyze data. The benefit of assigning an oral and written proposal is that the students are forced to finalize a priori how they will collect their data and to communicate that to their instructors. Thus the instructors approve the data collection process knowing that students will collect their data in a manner that is actually amenable to analyses! Typically designed are constrained to a 2 or 3 condition study, but sometimes groups will carry out a factorial design. Thus most students need to conduct t-test, one-way ANOVAs, or factorial ANOVAS. Many groups also conduct correlations. The instructors finish each data analysis meeting by providing the final output to the students and mapping out an outline for the results section. Handouts for how to draft up research findings for each kind of statistical analysis are provided, including sample write-ups. Heavy guidance is necessary since many of the students have not yet had a formal course in statistics.

By the end of Week 3, students have learned how to write each section of an empirical article and conducted their experiment. During Week 3 they also begin the process of peer review. For each of the primary sections of the manuscript (Intro, Method, Results, Discussion), students write a draft, receive (and give) peer-reviewed feedback, draft a revision, and then get instructor feedback on the revision. After getting feedback on each section, the students work on editing their entire paper before submitting it (due the night before the last day of class). This writing structure teaches the students that writing a manuscript takes place in small, manageable pieces. They learn that revision and feedback is critical at each stage of the process. They also learn by reading their classmates’ papers (papers by members of their own research groups as well as other groups). Having the students do peer review on the first draft and then a revision ensures the instructors read a draft that is worthy of feedback.

**Week 4: Interpret & Share Findings**

The final week of the course is dedicated to finalizing the manuscript, preparing the group’s poster, and presenting findings at a class symposium open to the entire campus. A special effort is made to invite older students who have taken the course previously, faculty from all the STEM majors, and some “higher ups” (e.g., Dean of Faculty, College President). The paper is deliberately due the night before the last day of class so that the last day can truly be a celebration! During the last class session—after the symposium—students are invited to reflect on their experience and share the “good, bad, and ugly” of their projects. Many students note how the experience of designing their own study and carrying out from start to finish has made them more excited to pursue their majors and many note a desire to join faculty members’ research labs and apply for summer research positions. Another subset of student typically note that despite the class being well-organized, they learned they don’t really enjoy taking part in research. Over the years several students have added psychology as a major (typically biology majors), after realizing it relies on the scientific method to the same extent as the “harder” sciences. Later in the spring semester all students are encouraged to present off-campus at a local undergraduate research conference and all are required to present at the on campus research and performance showcase at the end of the academic year (they are typically the only first year students at the event as most other presenters are senior thesis students, summer research students, etc.).

**References**

Allan, B.F., Keesing, F. & Ostfeld, R.S. (2003). Effects of habitat fragmentation on Lyme disease risk. *Conservation Biology*, *17*(1), 267–272.

Bernstein, M. J., Young, S. G., Brown, C. M., Sacco, D. F., & Claypool, H. M. (2008). Adaptive responses to social exclusion: Social rejection improves detection of real and fake smiles. *Psychological Science, 19*(10), 981-983.