

Department of Biological Science's Senior Thesis Program

Presented by Laura Vogel and Craig Gatto

(but really the contributions of many faculty!!)

Senior Thesis Program (implemented in 2000)

- Difficulty connecting lab experience with course work
- Research not being disseminated
(other faculty or other students)
- Not well prepared for lab experience
- Reading primary literature
- Use research to fill schedule in senior year (too late!)
- Poor communications skills



Address Problems by:

- Encourage students to start in spring of sophomore year/fall junior year
- Series of integrated experiences
 - BSC 293 – introduction to undergraduate research
 - BSC 290- undergraduate research
 - BSC 303 – senior thesis
- Each builds on core course work and increases skill levels
 - communication (written and oral)
 - primary literature
 - laboratory techniques



These skills are what our faculty feel are necessary for future success of our students



Now required for Departmental Honors

BSC 293 – Introduction to Undergraduate Research

Why do we require our Education majors to complete a semester of student teaching before being awarded a Bachelor's Degree?

Because it is our opinion that one must practice what they have learned about being an educator before one can be called a teacher.

Similarly, we apply this concept to Biology. That is, one does not become a Biologist by only learning what previous scientists have discovered. Rather one should apply the scientific method to novel questions and form conclusions based on observation.

BSC 293 is designed to prepare students to engage in an active and directed research endeavor.

BSC 293 – Intro to Undergrad Research

Ultimate goal - prepare students for BSC 303: Senior Thesis.

- To this end, BSC 293 will provide an introduction to the methodologies required for research in the biological sciences.
- Exercises are designed to help each student select and develop a potential research topic (with the support of their faculty advisor where applicable).
- Students learn how to research their topics and become familiar with the literature background necessary to begin/sustain a meaningful research experience.
- In addition, they will be challenged to develop an initial set of research goals and hypotheses.

Focus topics in BSC 293

Introduction to Senior Thesis – How and why to do one.

Asking the big question: The hypothesis behind your proposal

Beyond Milner – Library resources on- and off-line

The significance of it all – Just enough statistics

Data analysis: How to Excel, without even trying

A picture is worth a thousand words – simple programs for graphics

Scientific writing I

Structure of Research

- Most research projects share the same general structure.

1.) Start with a broad area of interest,

- i.e. the initial problem that you wish to study.

e.g.) Does recycling help the environment?

2.) Formulating a testable hypothesis.

e.g.) Recycling a particular material will improve the ground water of a specific district.

3.) Conducting direct measurements or observations.

4.) Analysis (trying to understand your data).

5.) Formulate initial conclusions

e.g.) recycling batteries decreased Ni^{2+} and Cd^{2+} content in local ground water because the number of batteries within the local dump significantly decreased

6.) Address original broad question by generalizing from results of your specific study.

** For instance, on the basis of strong results indicating that battery recycling decreased heavy-metal concentrations in the ground water, one might conclude that other similar districts might expect similar results from recycling.

Furthermore, several other “garbage” items can leach heavy-metals and thus recycling in general may be a beneficial for long-term environmental stability.

The "hourglass" notion of research

begin with broad questions

narrow down, focus in

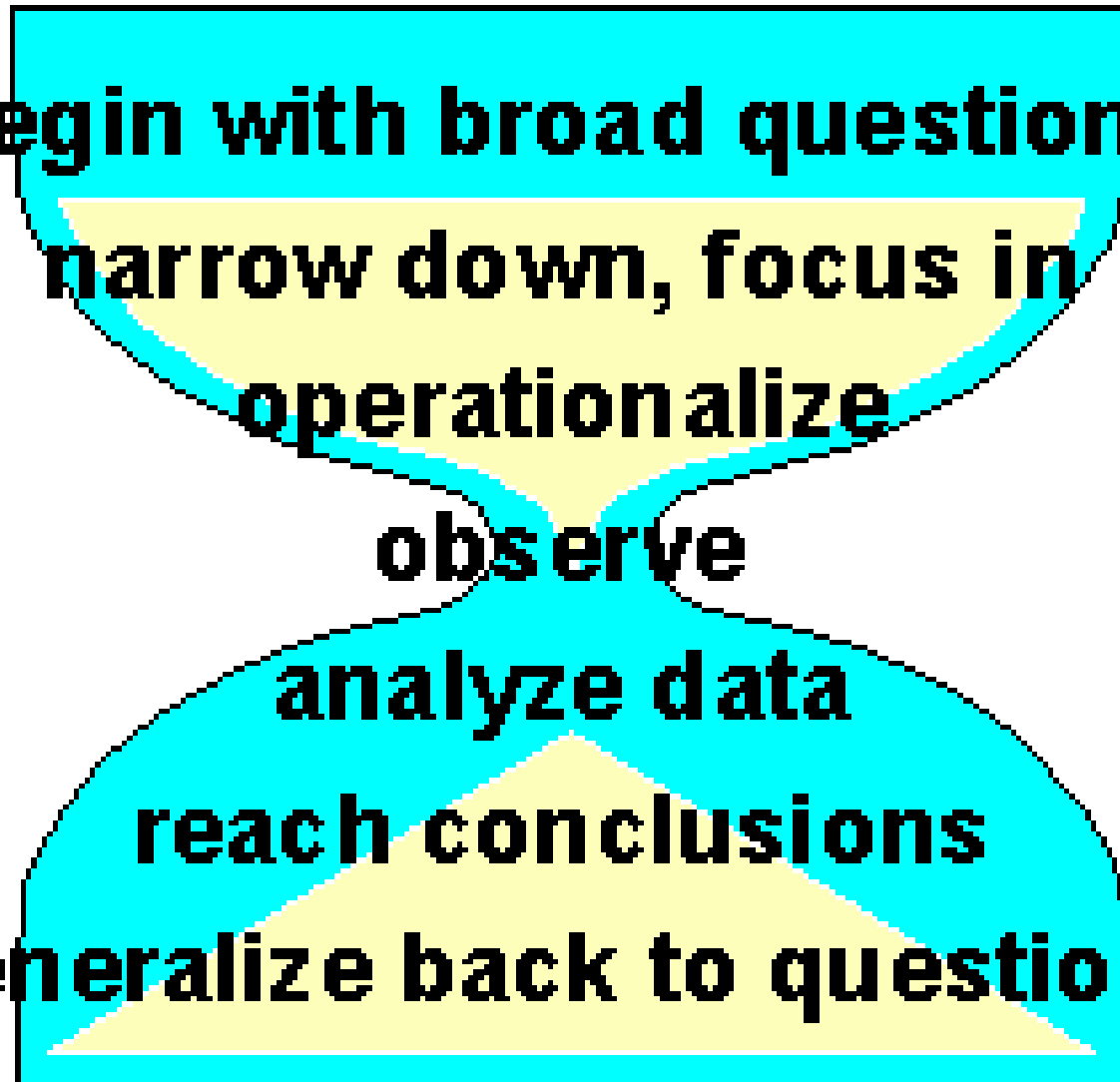
operationalize

observe

analyze data

reach conclusions

generalize back to questions



Communication

Two ways to communicate science: Speaking & Writing

BSC 293 Emphasizes both!

- 1.) Students write a research proposal of their thesis topic
 - NIH predoctoral fellowship format

- 2.) Students present a 30min seminar of their topic to the class.
 - Powerpoint presentation

RESEARCH PROPOSAL

1) Specific Aims (~1 page)

- Provide a clear, concise summary of the aims of the work proposed and the hypotheses to be tested.

2) Background and Significance (~3-4 pages)

- State concisely the importance of the research by relating the specific aims to broad, long-term objectives.
- State concisely the relevance of the research.

3) Research Design and Methods (~3-5 pages)

- a) Experimental design and procedures to be used to accomplish the aims;
- b) tentative sequence for the investigation;
- c) statistical procedures by which the data will be analyzed;
- d) potential difficulties and alternative approaches to achieve the aims

4) Ethical aspects of the proposed research (~1 page)

- Describe consideration you have given to all ethical issues involved in your proposed work (biohazards, human or animal subjects, etc.)

5) Literature Cited

- List all literature references. Authors, title, name of the book or journal, volume number, page numbers, and year of publication. References should be limited to relevant and current literature.

Next Step: BSC 290 Undergraduate Research

- Students conduct experimental research with a faculty member
- Work from proposal developed in BSC 293
- One-on-one mentoring
- Interaction with graduate students



Communication – oral -now more technical, advanced audience
written- keep lab notebook

Primary literature -expect advanced reading/questioning

Lab techniques - perform them, gather data
Trouble shooting

Most students will spend 2-3 semesters conducting the research

Finally: BSC 303 Senior Thesis

- Students write up their research results in the form of a Master's thesis
- Mentoring from Associate Chair for Undergraduate Studies and faculty advisor
- May go through several drafts; final is deposited in Dept. office
- Must defend thesis to committee (two faculty members)

Lab techniques – interpretation, presentation, and significance

Primary literature – build on introduction from proposal; explain why other studies support/disagree with their data; critically evaluate others' work

Communication – oral – must give presentation at local or national meeting as well as the oral defense
- written – abstract, poster, thesis, hopefully a manuscript!

Where do our Thesis students go after ISU?

<u>Student</u>	<u>Currently</u>	<u>University</u>
Jason Layman	Medical School	St. Louis University
Stephanie Shoemaker	Veterinary Medical School	Univ. of Illinois
Melissa Grunloh	Medical School	Univ. of Illinois
Jennifer Parker	MD/PhD program	Stanford University
Megan Prasse	Pharm. D. program	Univ. of Illinois-Chicago
Beth Helmink	MD/PhD program	Washington University
Jamie Baldwin	PhD Program	Univ. of Wisconsin
Trevor Martin	Medical School	Des Moines University OM
Andy Denison	Medical School	Ross Medical School
Rosemarie Zar	Professional School	Moorpark College, CA

<u>Student</u>	<u>Honors and Awards</u>
Jason Layman	Bone Scholar , Summer Honors Fellowship
Melissa Grunloh	Summer Honors Fellowship
Jennifer Parker	Goldwater scholar , Bone Scholar , Beckman Scholar, Summer Honors Fellowship, Red Tassel
Megan Prasse	Summer Honors Fellowship, CAS news spotlight, Red Tassel, Biophysical Society Travel Award
Beth Helmink	Goldwater scholar , Bone Scholar , Beckman Scholar, Summer Honors Fellowship, Red Tassel

Future:

- Only 10 students have completed this program in the last 5 years
- Encourage more students to get involved
 - many sign up for 290, miss 293
- Loose students between 293/303 – why?
- More faculty involvement

