

Chapter 20

A Guided Inquiry in a Computer-Based Biology Laboratory

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Dr. Laine is an instructor and molecular biologist in the Biology Department at Xavier University. She has taught more than 30 years in several institutes of higher education. She was the Scientist Educator for Project Discovery in the Southwest Region of Ohio 1994-1997. Because of her experience with Project Discovery and numerous visits to area schools, she became interested and immersed in the “new way to teach science” via the inquiry method. Her goal was to introduce this approach to the Xavier non-major student in a Life-Science laboratory that was using the traditional approach. She and Heath received a two-year NSF, Course, Curriculum, and Laboratory Improvement grant DUE # 9950373 to accomplish this goal. A new course and laboratory manual, *Discovering Life Science*, was developed. It has been purchased by Pearson Custom Publishing Company and will be available January 2002.

Linda Heath taught biology for 35 years, with a recent emphasis on science education. She teaches “Plants in the Inquiry Classroom,” a weeklong workshop for pre-service and practicing teachers and is active in presenting school in-services.

Laine and Heath are available for consulting on how to implement the inquiry method into laboratories.

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Introduction

This exercise is used during Phase I of a Biology laboratory course designed for the non-major student. The focus of the course is to implement inquiry, technology, and science writing into the laboratory experience. Students work in cooperative teams.

Course Objectives

1. Students will work in cooperative groups.
2. Students will use the scientific method to understand process skills.
3. Students will practice and use critical thinking skills.

4. Students will communicate thoughts and ideas in written and oral form.
5. Students will design and execute original inquiry investigations.
6. Students will be assessed in non-traditional ways.
7. Students will increase computer communication skills.

Course format

The format for this course consists of three phases, during which students carry out inquiry-based investigations. The title of each phase, the students' activities, and the role of the instructor are described below:

<i>Phase I:</i>	<i>Experiencing Inquiry (Weeks 1 through 6)</i>	
	Student Activity:	Experiencing Inquiry Investigations
	Role of Instructor:	Coaching and Evaluating Participation
<i>Phase II:</i>	<i>Practicing Inquiry (Weeks 7 through 9)</i>	
	Student Activity:	Practicing Inquiry Investigation
	Role of Instructor:	Guiding and Evaluating Process
<i>Phase III:</i>	<i>Performing Inquiry (Weeks 10 through 14)</i>	
	Student Activity:	Performing Inquiry Investigation
	Role of Instructor:	Facilitating Process and Evaluating Product

Inquiry teaching involves the instruction of a process, the process of science. The exact science content of this course will vary, and is viewed as a part of the process of learning science, not as the focal point. Instructors need to be sensitive to the dynamics of the inquiry process so the teachable moments, closure times, and students as teachers can all maximize content learning.

Electronic Course Components

SI – Student Instruction

The student instructions for this laboratory are written in Microsoft Word 97. They include the learning outcomes, a brief introduction, directions for the specific activities, assessment, and references. The instructor may choose to use these in either electronic or paper copy form. The format used electronically is Online Layout View, accessed under the View menu. In Online Layout a document map, an outline of the student instructions, appears on the left of the screen. If one left-clicks any of the items in the outline, that item will appear at the top of the screen, allowing quick movement through the document. This format does not appear in the print copy. All 14 student instruction documents are located in a SI folder, which is read-only so students cannot change them.

Template (TLNB – Team Lab Notebook)

Each laboratory exercise has a companion template called the Team Lab Notebook or TLNB. The template is also written in Microsoft Work 97 to be displayed in Online Layout View. At the beginning of a new lab, each team makes a copy of the template to use for recording its own work. It is saved as a file in a Team folder within the Dropbox folder for their section. The format of these documents is user-friendly and correlates directly to the student instructions. Each team produces their own unique laboratory notebook because their inquiries, searches, questions, predictions, *etc.*, are different. The team files, or portions of the files, for each lab can be printed and turned into the instructor or the instructor can check the TLNB electronically at his/her leisure.

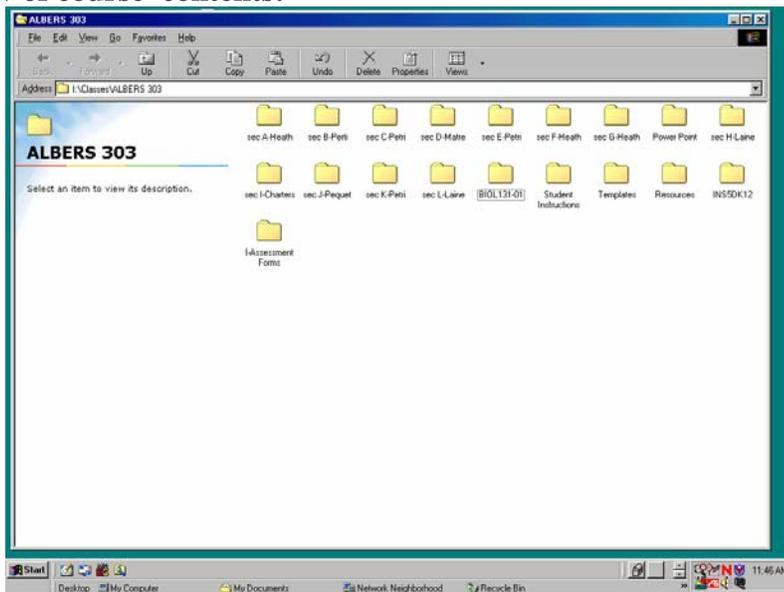
Resources

An electronic resource folder is available for both instructors and students. This contains science content information that can be used at any point in the lab during “teachable moments.” Students can refer to this to obtain additional information for their independent inquiries. Some of these resources were developed and assembled during the pilot studies using student questions on science content or to fulfill instructor’s needs. The contents of this folder vary depending upon the preferences of individual instructors.

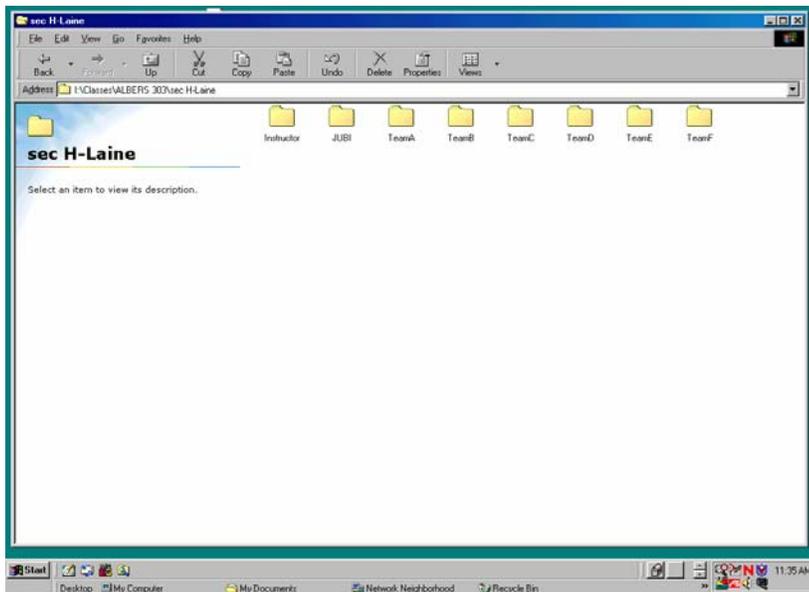
Journal of Undergraduate Biological Inquiry (JUBI)

Teams are asked to submit completed research articles to JUBI -- Journal of Undergraduate Biological Inquiry -- an electronic course journal. This folder contains the final team inquiries for a given semester. It serves as a departure point (idea bank) for future inquiries by future sections. Research teams can be required to check past JUBI folders to insure their inquiry has not been researched and submitted by a prior team.

Electronic view of course contents:



Electronic view of one section:



The Guided Inquiry



What is the preferred habitat of an isopod?

Overview

Teams will conduct a guided inquiry. The instructor asks the question and also explains the data-recording method (10-second check) because the data will be used to teach Microsoft Excel graphing. Students need to understand the independent and dependent variables of the experiment. The engagement process introduces concept mapping to organize background information the teams gather from the Internet and laboratory library. The concept map is designed on plain paper and scanned into the TLNB. If a scanner is not available, one can use Inspiration Software to create a concept map. One member from each team needs to be taught how to use the scanner so they can be a “team teacher” for future use. This is an excellent lab setting to discuss true observation and inference. This is a busy lab, but teams revisit this inquiry during later exercises when they use this information to write their first JUBI science article.

Learning Outcomes

The students will:

- practice process skills: predict outcomes, design pillbug habitat,
- identify variables, perform experiment, collect data, analyze data, draw a conclusion based on evidence, understand true observation and inference.
- generate data and use Excel software for graphing.
- examine WWW and other resources to locate information about isopods.
- organize isopod information by designing a concept map.
- present concept map to class.
- present inquiry data, if time permits.

Materials

Laboratory

- colored pencils (in room)
- tea
- 70% ETOH
- 1% starch
- vinegar: distilled and apple cider
- apple juice
- coke
- coffee
- 5% gelatin
- yogurt
- wine
- yeast suspension
- beer
- water
- yogurt suspension in H₂O
- yeast suspension in H₂O

Supplies (per team)

- critter cage for isopods after experiment
 - data chart (10 second method) – paper copy
 - 8 x 11” plain paper
 - 30 isopods in container with moist paper towel
- Normal inquiry materials are needed at all times in an inquiry-based facility. Other materials can be obtained by student request.

Technical

- Microsoft Excel software
- scanner (optional)
- Microsoft Word
- Inspiration software (to produce concept map)
7412 SW Beaverton
Hillsdale Hwy, Suite 102
Portland, Oregon 97225-2167
Phone (503)297-3004
Fax (503)297-4676
www.inspiration.com

Notes for the Instructor

Method

Students work in groups of 3-4 with supplies in central location. We call the groups research teams or review teams.

Introduction Ideas

This is the second lab of the introduction phase. Instructors should begin with a quick review of the process skills from lab one and connect these to the new lab. Point out the new skills: background searching, organizing information in the form of a concept map, learning how to use the scanner, Microsoft Word Excel software, and Inspiration. The focus of the guided inquiry in this lab is to generate data to use for learning how to graph with the Microsoft Excel program. The 10-second check data collection approach needs to be explained. The teams are responsible for

designing the “isopod habitat” that will permit them to produce these data. Each team has been given 30 different isopods in a container. They are to choose a substance (x) as their independent variable. Limit the time of the experimentation portion of the lab to permit time for teaching Microsoft Excel.

To help teach Microsoft Excel, refer to the Technology Appendix C (in lab manual). An example of a completed graph is presented in the student instructions. The resource folder contains electronic examples. The individual homework assignment requires students to practice this new skill using data examples. Each student is asked to turn in a completed graph in the beginning of the next lab.

Suggested times to complete the laboratory

- A-1 background searching - 10 min.
 - A-2 organizing information and concept mapping - 15 min.
 - A-3 inquiry – 30 min.
 - A-4 teach and use Excel – 30 min.
- Presentation by research teams – 20 min. (optional)

The guided inquiry process

A-1 Gathering Background Information

To begin the engagement step for the isopod guided inquiry, students will explore URLs and resources that are part of the laboratory library. All information needs to be recorded in their TLNB.

A-2 Concept Mapping

Teams have been given an example of a concept map as part of the student instructions. They can also refer to a URL or lab library reference. Maps will be drawn on an 11 1/2” x 8” plain sheet of paper. One team member will learn how to scan the map into the TLNB. The alternative method is to teach the teams how to use Inspiration software (<http://www.inspiration.com>). The lab manual contains instructions in the Technology Appendix C.

A-3 The Inquiry

Question: Do isopods prefer water or substance X?

Students Research Teams choose substance X.

Substances available are listed in the materials section. The student instructions tell the research teams to begin with a prediction. They are to enter the prediction into their TLNB. The 10-second check method needs to be explained to the teams. Again the focus is to generate sufficient data to use in learning Excel.

Teams will be given a paper copy of a data table to record their results. They will record the # of bugs in each environment for 10-second intervals for a total of 1 minute. Teams should do three trials and calculate the average for each minute. In addition, the research teams need to identify the following:

- a. What is the control?
- b. What is the dependent variable? (what is measured)
- c. What is the independent variable? (what research team changes)

A-4 Data Analysis

Each research team will produce a BAR GRAPH to represent the summary of the data generated by the research team. If time permits, one team or all teams will present their graph to the class. Completion of a graph can be used as a team assessment.

The instructor needs to explain the following graphing guidelines. Appendix D on science writing in the lab manual reinforces these ideas.

- The independent variable is shown on the horizontal or x-axis.
- The dependent variable is shown on the vertical or y-axis.
- Each axis is labeled with the name of the variable and any units of measurement.
- The graph is given a descriptive title.
- You should be able to understand a graph without reading any additional explanatory text.

Optional: If time permits the research teams can share their concept maps and experimental results to the review teams. This oral presentation can also be used as a team assessment.

Closure Ideas

1. After a Research Team presents its ideas using the concept map, reinforce briefly any terms the students used that might need clarification for the entire class. Instructors may also choose to discuss science terms with each team as the teams are constructing their individual maps.
2. The real focus of this lab is to practice the process skills of data analysis and use of Excel software. Be sure the students thoroughly understand the concept of experimental controls and variables. After the graph presentation, ideas on pillbug kinesis can be discussed. The resource isopod materials folder (file name animal behavior.doc) contains the following information about animal behavior:

Animal behavior can be described as:

 - Taxis: movement toward or away from a stimulus
 - Kinesis: random movement that is not oriented to the direction of a stimulus
 - Agonistic: confrontation of two animals, which may result in a submission or aggression
3. Spend time addressing experimental design flaws and what questions remain at the end of this inquiry.
 - What would the team do next?
 - What did the team learn from doing the inquiry?
 - What did they learn from other presenters?
4. Be sure students understand the difference between a true observation and inference.

Related Ideas

Other living organisms that might be used to generate data for Microsoft Excel include: termites, Daphnia, ants.

Suggested Assessments

- Team:
1. Evaluate a print or electronic copy of the team's concept map which summarizes their background information on isopods.
 2. Evaluate a print or electronic copy of the team's bar graph.

- Individual: 1. Each student can be given a set of data to produce an Excel graph. A print copy or e-mail copy needs to be turned into the instructor.
2. Each student can write a paragraph on his/her reflection of the inquiry. Include questions listed in #3 of Closure Ideas.

Safety concerns

Some solutions may be harsh on the skin, i.e., vinegar.

References/resources

Textbooks: General Biology Textbooks

Search Engines:

General

<http://www.hot.bot.com>

<http://www.altavista.com>

<http://www.webcrawler.com>

<http://yahoo.com/>

Science

www.sciencelink.com/index.html

www.sciencenetlink.com/index.html

www.britannica.com

- Books: Burnett, R. 1992. The Pillbug Project. National Science Teachers Association.
- Ross, M., B. Grogan, and D. Erickson. 1995. Rolypoly-ology. (Backyard Buddies). Carolrhoda Books.
- Schaffer, D. 1999. Pillbugs. Capstone Press.

Article: Gadsby, P. 1999. "How Now, Sow Bug?" *Discover*. Aug., pp 64-67.

URLs:

<http://www.geocities.com/siliconValley/Campus/3381/crust4.html>

<http://www.natures-web.org/>

<http://animaldiversity.ummz.umich.edu/>

<http://www.ex.ac.uk/bugclub>

<http://www.oit.itd.umich.edu/projects/adw2K/index.html>

Student Template To Use Electronically

TEAM LAB NOTEBOOK (TLNB)

EXERCISE 2 Learning More Skills

Inquiry:



What is the Preferred Habitat of Pill Bugs?

By: Student One Name
 Student Two Name
 Student Three Name
 Student Four Name

Date: *(enter date here)*

Introduction: This is the second time our team will practice a guided inquiry. The subject of the guided inquiry was the preferred habitat of pillbugs.

ACTIVITY 1: Gathering Background Information

Our first step was to gather background information on pillbugs. We found the following information in the following sources:

(Enter the information and sources below)

ACTIVITY 2: Concept Mapping

Our team designed the following concept map to summarize the information we discovered about pillbugs.

(paste here from scan image)

ACTIVITY 3: The Inquiry

Our Team chose _____ *(fill in)* to compare with WATER as a preferred habitat of pillbugs.

QUESTION:

Our team's research question was, "Do pillbugs prefer water or _____?"
(State your team's research question)

PREDICTION:

Our team predicted that...
(write in the form of an if/then statement)

EXPERIMENTAL DESIGN:

We constructed a laboratory habitat that was...
(enter a description of your setup)

These were the components of our experimental design:

Our control was _____.

Our dependent variable (what we measured) was _____.

Our independent variable (what we changed) was _____.

METHOD:

Our team used a "ten-second check" method to generate data.
(describe)

DATA (results):

We used the paper chart in the lab instructions to record our data. The results appear in the chart below.

(you will be pasting a table from Excel into this space)

ACTIVITY 4: Data Analysis

From the chart we generated the following bar graph.

(you will be pasting a bar graph from Excel into this space)

CONCLUSION:

Our conclusion was _____.

References

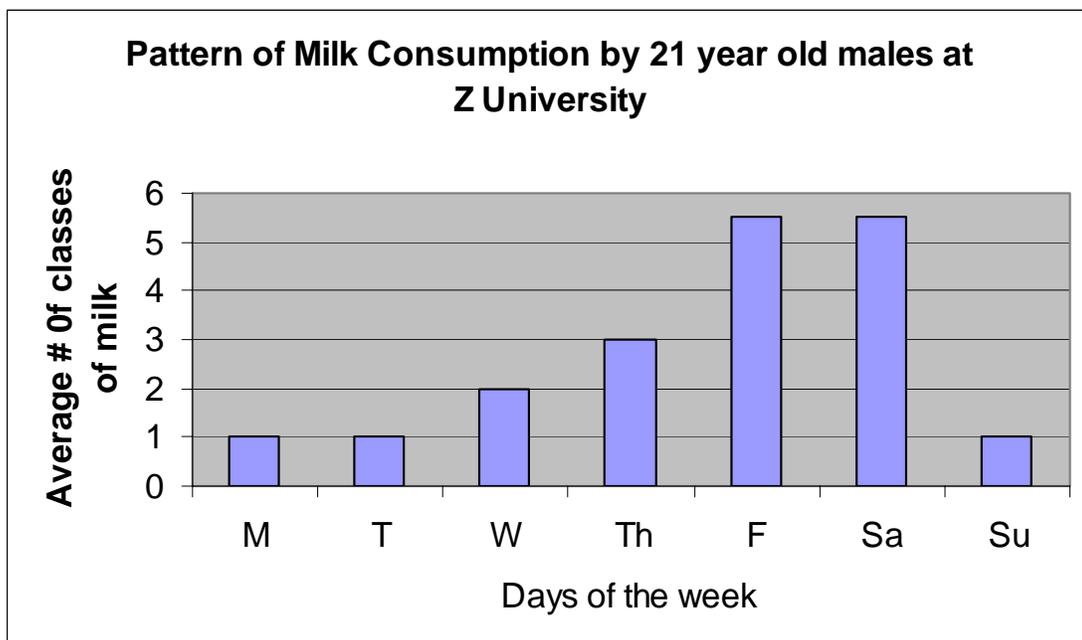
- Ausubel, D. P. 1968. *Educational Psychology: A Cognitive View*. New York: Harper & Winston, 685 pages.
- Barnekow, D. J. 1998. *Graphic Organizers for Science Classes*. Portland, ME: J. Weston Walch, 86 pages. ISBN 0825137567X
- Inspiration. 1991. Portland, OR: Inspiration Software, Inc.
- National Research Council. 1996. *National Science Education Standards*. Washington, DC. National Academy Press, 262 pages. ISBN 0309053269
- Novak, J. D. 1998. *Learning, Creating, And Using Knowledge: Concept maps as facilitative tools in schools and corporations*. Mahwah, N.J.: Erbaum Associates, 251 pages. ISBN 0805826254
- Westhaver, M., and M. Kimberlin. 1998. *Classroom Ideas Using Inspirations: For Teachers*. Portland, OR: Inspiration Software, Inc.

APPENDIX A**Example of data**

This example (not real data) is part of the Student Instructions. It can be used to teach Microsoft Excel as well as how to graph data.

DATA CHART: In Resource folder – (file name is excel example.xls)

DAYS OF THE WEEK	AVERAGE # OF GLASSES OF MILK
M	1
T	1
W	2
TH	3
F	5.5
SA	5.5
SU	1



APPENDIX B

Example of a research team's concept map

