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Combining Inquiry- and Service-learning Activities

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Introduction

Over the last quarter of a century the ABLE workshop/conferences have provided biology laboratory instructors with many examples of laboratory exercises which aim to facilitate student participation in science. These exercises have been instrumental in expanding the nature of the science conducted by biology students in their laboratory courses from observational to inquiry-based activities (Preszler 2004). This pedagogical change in laboratory design has shifted the primary source of information for students from their instructor to their experiment. Many students are now learning biology by conducting science. While designing and implementing inquiry-based laboratory exercises, I have found that most students in our biology laboratories eventually meet the objectives of inquiry exercises: they generate hypotheses, design and conduct experiments, and evaluate their hypotheses. However, many of these students struggle when asked to develop the implications of their work.

Students' inability to develop meaningful implications of their research suggests they will be unable to apply their knowledge of biology outside of their biology course. As a result, when the course is done, their knowledge of biology will rapidly decay. This problem may be due to the lack of hands-on work associated with development of implications. While most of the laboratory experience is associated with hands-on work resulting in meaningful learning, we typically ask students only to discuss implications rather than act on them. The solution to this problem may be the development of exercises which combine inquiry learning of scientific process with service learning of the implications of the knowledge generated through the inquiry activity. Service learning promotes learning through active participation in service activities that benefit both the students and their community (NSLC 2004). Service learning has beneficial impacts on students' academic, social, and professional development (see extensive bibliography of studies of the impact of service learning in Eyler et al. 2001).

The following section summarizes a combined inquiry- and service-learning activity, the diabetes project, we have developed at New Mexico State University (Preszler *et al.* 2005). Although the combined project takes 14 weeks, much of the work is done by student groups outside of class, while in class students are working on other weekly activities.

The Diabetes Project

The following Sections describe the overall structure of the project and also indicate landmarks that can be used to evaluate student performance throughout the project, rather than

limiting the evaluation to the final product. I suggest giving students the opportunity to help develop the grading rubric, determine how many potential points are associated with each stage of the project, and determine if these points are based on group or individual performance. This motivates students to think carefully about the overall structure of the project, and it helps convince them that the grading system is valid.

Literature Search

After providing students with an introduction to the structure of the project, Type 2 diabetes, and with guidelines for working as a team, we ask students to conduct initial library research about risk factors associated with Type 2 diabetes. This first step is an individual assignment to encourage each student to become actively involved in the project. In order to help them learn to effectively conduct library research we refer them to a section of an appendix in the laboratory manual (Preszler *et al.* 2005) titled “*The place of library research in scientific reports*”. To help them assess the validity of web sources, we refer them to sites at:

Stanford (<http://www.webcredibility.org/guidelines/>),
Cornell (<http://www.library.cornell.edu/olinuris/ref/research/webeval.html>), and
Berkeley (<http://www.lib.berkeley.edu/TeachingLib/Guides/Internet/Evaluate.html>).

Additionally, we require that each student submit written answers to at least 4 of the following 9 questions:

1. What risk factors contribute to the chances of developing Type 2 diabetes?
2. Which population or subgroups of the population tend to have higher rates of Type 2 diabetes?
3. How does the local risk for Type 2 diabetes compare with the national risk?
4. What can be done to reduce or eliminate the possibility that one might develop Type 2 diabetes during his or her life?
5. Once a person develops Type 2 diabetes, is there a medical cure for the condition?
6. What is pre-diabetes? What is insulin resistance?
7. What are the symptoms of Type 2 diabetes?
8. What life-threatening or other severe conditions can develop in a person with diabetes over time?
9. Once a person develops Type 2 diabetes, what kinds of lifestyle choices or medications can reduce the chances of developing life-threatening diabetic complications?

Hypothesis Formation

The second week we form student groups in class, and provide groups with time to discuss their answers to the first week’s library research questions. These discussions then lead into brain-storming sessions focused on forming a hypothesis about risk factors and behaviors associated with Type 2 diabetes in our local populations. We then ask each group to work outside of class to develop an experimental design that could be used to test their hypothesis. We provide students with the following guidelines to help them as they design their research project.

Experimental Design Guidelines

When you work with your team to formulate the research plan, take it one step at a time. Keep your hypothesis in mind, and consider the various ways you might test it. Here are some questions to guide your design of the study:

- 1) Selecting the participants for your study is an important consideration. You are attempting to use the research as evidence about an entire target population.
 - (a) How many people will be selected to participate in your study?
 - (b) How will you select a study sample that adequately represents the population you seek to study? Randomly (e.g., from the phone book), or based on a set of people that you know will be willing to fill out your survey?
 - (c) Will you limit your selection to one gender, age group, dormitory, or ethnic background?
 - (d) How might your particular selection unintentionally *bias* or influence the results?
- 2) The longer it takes for each subject to provide the data you request, the less they may want to participate, and the longer it will take you complete the data collection.
 - (a) How will you get enough of the right kinds of data, without wasting your subjects' time by over collecting?
 - (b) What are the *most important* data you will need before you can estimate an individual's risk for developing Type 2 diabetes?
- 3) What methods of gathering data about your study subjects will provide the most useful information? (Review the section, "Some words about Privacy")
 - (a) Interviews?
 - (b) A short survey?
 - (c) What other methods might you use?
- 4) How will you ensure the anonymity (confidentiality) of the participants in the study?
 - (a) Your instructor will want detailed descriptions of this aspect of your research. You may NOT collect any identifying information (i.e., social security number, phone numbers, names, etc.) that are connected with the participant's data.
- 5) How will you *define*, and therefore *measure*, "risk" in your study? Will you attempt to estimate the risk for your sample as a group, or for each individual subject?
- 6) What are the specific tasks you and the members of your team must complete in order to collect all the data?
- 7) Which members of your team will be responsible for each task?

The Research Project

During the third week, each group turns in a co-authored research plan. This plan includes an introduction to their project, a proposed methods section, and an individual responsibilities section which includes a timeline listing when each group member's tasks need to be accomplished. By the end of the fourth week we require that each group meet with their instructor to discuss their research plan. In addition to discussing the plan with the entire group, the instructor will ask individuals questions about the proposed research to assess each individual's understanding of their coauthored research plan. Before approving the plan, the

instructor makes sure it will not impose on members of the community. Students have been given extensive information about how to insure subjects' privacy during census work. The instructor also will ask questions intended to help students discover potential improvements to their plan; however, instructors do not fix the research plan. It is important that students maintain overall control of their project.

For the next five weeks student groups conduct their research and write a formal research report. By this time, students have had extensive experience writing weekly laboratory reports describing their in-class experiments.

The Service-Learning Project

After having completed their research project, students form a service-learning plan to act on the implications of their research. We provide students with the following information to help them get started on their service-learning plan. As with the research project, groups are required to meet with their instructors prior to implementing their service learning project.

Service-Learning Guidelines

Now that you have researched the problem of diabetic risk in a population of interest, consider the implications of your study. The next phase of your diabetes project will be to develop an action plan based on your research findings that your team will implement over the next few weeks. In the discussion section of your research report you considered the implications of your conclusions; now you get to act on those implications. Your first task is to work with your team to brainstorm the wide variety of activities, screenings, education, or other strategies that may be done to reduce diabetes in your target population. It may be helpful to list many things that could be done, without regard to time, cost, or effort, and then begin to prioritize your list to the more manageable strategies.

Here are some questions to start your brainstorming:

- 1) What do your research conclusions imply should be done?
- 2) What is needed in this population in order to reduce its risk of developing the disease?
- 3) Are any of the risk factors you identified in the target population within control of the individual?
- 4) Which risk factors are not controllable?
- 5) What are all the possible strategies that might reduce the risk for developing Type 2 diabetes in the target population?
 - (a) Which of these activities might *appeal* to your target population?
 - (b) Which of these activities might be the *most effective* at making an impact on the individual risk for developing Type 2 diabetes?
- 6) If you had the time to do it, how would you determine whether your action plan had a long-term effect (actually reduced the numbers of people who developed Type 2 diabetes)?

The Service Learning Project and Presentations

If students have stayed on schedule, completed their research project and received approval for their service-learning project, they have three weeks to conduct their service-learning project. At the conclusion of this project, each group orally presents a brief summary of their

research, a description of how the implications of their research led to the development of their service-learning project, and a description of the impact of their service-learning project on the community.

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