

Teaching Methods

Research on Human Issues in Horticulture Motivates Students to Learn Science

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Summary. Many undergraduates major in horticulture because they love working with plants. When they hear research that documents how people respond to plants, some students begin to understand why they have responded positively to plants, and they want to learn more about the topic. This paper 1) discusses the potential to use students' excitement about human issues in horticulture to teach principles that educators consider important components of a baccalaureate degree, and 2) presents the case of one student to demonstrate how it can be done.

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Many teachers come to realize that teachers don't teach-learners learn. Teachers can facilitate learning, but the real task of learning must be done by the student. Motivation is a major factor that promotes learning (Orlich et al., 1985). Teachers can motivate students by conveying excitement for their subjects. Students also can motivate themselves when they are excited about a subject or when they have a strong desire to accomplish something. Many students are captivated by research on human issues in horticulture, such as that reported by Fisher (1990), Kaplan (1973), and Ulrich (1984); this can contribute to their excitement about learning more. This natural excitement or motivation can be used by a teacher to expand students' thinking skills and to help them learn more than if their curiosity is unaddressed and they are left to develop on their own.

Independent research projects carefully supervised by faculty can expand students' excitement for learning. In fact, some authorities believe that much of the learning at universities occurs outside of the classroom in projects such as these and through informal discussions with faculty (Boyer, 1987; Chickering and Gamson, 1987). Exploring ideas with peers with whom the students are comfortable is another major source for this form of learning. Internally motivated students, inspired by research on human issues in horticulture, spend time discussing the topic with fellow students. The more time students spend outside of the classroom discussing issues related to horticulture, the better they are likely to perform inside our classrooms.

Independent research projects can help students understand science.

Many common scientific principles can be difficult for students to comprehend (Pool, 1990). They hear, for example, about experimental designs, the need for repetition, or problems associated with high variability. They may memorize the correct answers to questions about such matters, but they do not really understand the importance of these topics. An independent project that interests them and allows them to relate specific principles to their research will help them grasp concepts teachers would like to get across, because students must master simple learning tasks before they can handle complex ones (Lohr and Cotter, 1984; Orlich et al., 1985). The students use their understanding and interest in their specific project to help them grasp the more difficult generalizations.

In this article, I present the case of one student who was inspired by information on human issues in horticulture. She went on to conduct independent research and perform at higher levels than expected from someone with her academic record. I show, through this example, the types of information that can be presented and mastered by such students. I also present some of the data from her research. This example shows that many of the experiences considered essential in a baccalaureate education, including inquiry, critical analysis, literacy in writing and reading, understanding numerical data, and in-depth study (Assn. of American Colleges, 1985), can be addressed with this type of project.

I have often included information on human issues in horticulture in the courses I teach, and I have been a guest lecturer on the topic in other courses. I stress, for example, that students should know all they can about the benefits of plants so that they can justify spending money on the products and services of their chosen profession to potential consumers.

One student, who was working for me part-time during the summer doing routine jobs in the laboratory, such as washing dishes, often asked questions about the topics on human issues in horticulture that I had been raising. She was a very outgoing student who was quite active in departmental activities. She was not one of our best students academically, but she was willing to work hard when she was interested in something.

The College of Agriculture and Home Economics at Washington State Univ. initiated a small granting program for undergraduate students to conduct research. I asked the student if she would be interested in helping me prepare a proposal so that we could work together on a project related to human issues in horticulture. She was enthusiastic about the opportunity to conduct her own research and readily agreed to the terms we worked out.

We decided to plan a project that could be expanded or cut back, depending on the resources available. This meant that even if we did not get the grant, we could still pursue part of the research with the resources I already had available. It also meant that she would have the opportunity to explore a variety of options, while being sure of some payback for her efforts. We had heard that the director of the college's computer teaching lab wanted to improve the appearance of the classroom by adding interior plants and decided this would be an ideal site for monitoring the impact of plants. We grouped the potential impacts into two broad areas: air-quality parameters and human-response parameters. The number of parameters we measured could then be a function of the size of the resources available for the project.

Through this project, the student grappled with many difficult concepts and improved her skills in numerous areas. For example, she began her preparations for this project as any student should, with a review of the literature. I gave her overview articles that were easy to understand (e.g., Fisher, 1990; Weyerhaeuser, 1986), as well as refereed articles covering scientific research that were more difficult to comprehend (e.g., Kaplan, 1973; Moore, 1981; Wolverson et al., 1984). She devoured all of them, then went to the library searching for more.

The student's writing skills were called upon when I asked her to help draft the proposal. This led to discussions and readings on how to prepare proposals and on the components of good writing in general. The student, inspired by the topic and by what she had been learning, had little difficulty responding to my request and preparing the first draft. I was pleasantly surprised and pleased at the quality of her work. It was much better than I had anticipated from an average undergraduate who had no experience

with this form of writing. She learned the importance of revisions, both by doing and by watching, as she saw what we thought was a good beginning become more thorough and understandable.

Discussions covering the various parameters that could be measured, such as relative humidity, formaldehyde, blood pressure, and anxiety, generated interest in learning more about different ways of measuring these parameters. Again, she spent time reading about these. She also met with various scientists on campus to ask about equipment and how it operated. This was an important contribution to her informal education. As the student became more aware of how much work and time would be involved in measuring different parameters, she came to realize that we would have to limit our efforts. By initially pursuing all options, she was able to see for herself the need to limit the parameters.

Data collection initially seemed straightforward to the student. She thought we could start measuring air-quality parameters and human responses while we were obtaining plants, then install the plants and remeasure the same parameters. After discussions on the need for random sampling, repetition, and appropriate controls, she came to understand the need to design the experiment so that the plants could be moved in and out of the room repeatedly during the sampling phase.

I wanted to be sure the student would understand some of the innumerable ways that variability could be introduced into experiments and to impress upon her the need to follow procedures. Her decision to monitor CO₂ levels by taking air samples provided a good opportunity. I asked her to begin by experimenting with different ways of taking the air samples. Her procedure was to draw air samples into a syringe. I asked her to obtain samples at various locations within the room and at different heights, times, and positions. She was particularly interested in learning how the direction she held her head while taking samples could affect results. She learned that if she laughed while taking samples, it introduced even more error than if she talked while taking the sample. This type of first-hand experience helped her understand later discussions on complex ideas involving analysis of results and statistics.

This student experienced severe "math anxiety"; she had had great difficulty in elementary-level mathematics courses. During this project, she was often exposed to mathematical and statistical concepts. For example, she used a gas chromatograph for determining the level of CO₂ and O₂ in her air samples. She had to run standards and do conversions, including the use of different attenuation factors. She handled all this successfully. She became skilled at using a spreadsheet program and understood how to correctly enter various formulas. She helped enter data into a statistical program and was able to do some elementary interpretation of the results. Her in-depth and intuitive understanding of exactly what she was doing and why helped her accomplish what otherwise would have been a very threatening situation to her. Unfortunately, this positive experience did not eliminate her general anxiety regarding mathematics, but it did help her see that the problem was not that she had no abilities in this area.

Not all learning comes from positive examples or from doing things correctly. While conducting this experiment, the student also learned by making mistakes. For example, when we began analyzing data, we thought that the temperature was significantly lower when plants were present than when they were not. We were extremely excited by this finding. When we looked more closely, however, we realized that there was a problem. One number had been entered incorrectly. Instead of 20C, the student had entered 209C. When we corrected this error, no significant temperature differences remained. On many occasions, the student and I had discussed the need for proofing data and the ease with which human error could occur. The student had proofed these data. This example helped emphasize the need for careful attention to detail as well as the strong effect that even one seemingly minor mistake can make.

Whenever mistakes occurred, we tried to turn them into positive learning experiences. This was not always easy. Some of our biggest problems related to communication among people. These problems can elicit strong emotions. By discussing them openly, we were able to address another important aspect of her education.

When the year-long project ended, we had noted one subjective and one objective measure of the impact of plants. The subjective measure dealt with interpreting the nature of unsolicited comments that the student received from the users of the computer room when they saw her in the room. Throughout the experimental period, the student noted that users spoke very favorably about the presence of the plants. Every time the plants were removed from the room for collecting data, the students complained bitterly to her about their absence. These comments, indicating that the users appreciated the student's contribution in selecting and obtaining plants for the room, helped keep her spirits high regarding the project.

The objective measure of a positive impact from the plants was relative humidity. Our experimental procedure was similar to that described previously (Lohr, in press). A variety of low-light-requiring plant species filled ≈ 5 of 275 m³ of interior space during 6 weeks of recording in the presence of plants. Data were collected during 5 weeks without plants. We monitored relative humidity by placing recording hygrothermographs at two locations in the room. Measurements were recorded between Feb. and May 1991. Relative humidity was noted every 3 h, and daily maxima and minima were analyzed. Results from data collected at one location are presented in Table 1; results from the other location were similar. Average relative humidity, daily maximum relative humidity, and daily minimum relative humidity were all higher when plants were present than when they were absent. The magnitude of the increase was small and did

not move the relative humidity into the range of 30% to 60% recommended for human health. This may have been due to the small portion of the room occupied by plants, smaller than that reported in a previous study in which the relative humidity in winter in the presence of plants did reach 30% (Lohr, in press). Stomatal conductance, measured soon after the plants were placed in the room, indicated that the stomata were at least partially open.

Projects such as this one require major commitments from faculty members, but the rewards can make it worthwhile. For people who love teaching, it is gratifying to see the enthusiasm that stems from such projects and to be a part of the student's quest for knowledge, fostering the interest and directing it in productive ways. This project has allowed one student to make great strides toward the attainment of skills considered essential to an undergraduate education (Assn. of American Colleges, 1985). The informal discussions generated by the project have contributed to learning by a much larger group of students. The enthusiasm this particular student felt for the project has sparked interest in others as well: students throughout the college have been discussing the project, and some have asked if they could become involved.

Any independent research project has the potential to lead to a similar positive outcome. Projects related to human issues in horticulture, such as measuring the influence of plants on people, are particularly effective because of the interest generated when people ask research questions that are really questions about themselves—a favorite topic for most people.

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Table 1. *Relative humidity (RH) in an interior space in the presence and absence of plants.*

Plants	Average RH (%)	Maximum daily RH (%)	Minimum daily RH (%)
Present	24.8	26.8	21.6
Absent	21.2	23.6	18.6
Significance	**	**	**

**RH in the presence of plants was significantly different at P = 0.01 from RH in their absence.