

To Follow in the Ways of Great Scientists: Inquiry-Based Learning with Portfolios

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What if students could explore science outside the classroom and laboratory?



Late one afternoon in lab, I watched a scene that faculty members have observed far too often. Students were mindlessly reproducing standard introductory laboratory experiments—experiments that someone else had designed. They were going through the motions, more intent on finishing the assignment and escaping lab than on learning concepts and doing science. They did not have ownership of their learning. They were not having fun.

What if students could explore science outside the classroom and laboratory? What if students could answer their own questions rather than questions that someone else deemed important? What if students were the scientists? Would science then be more relevant for them? Would students be more engaged? Would science be more fun?

To address these issues, Scientific Inquiry Portfolios have been implemented in an introductory general education Earth system science course (they have also been used in lower- and upper-level physics courses). The portfolio utilizes an “inquiry-based” learning approach. Throughout the semester, students document their *own* observations, scientific questions, hypotheses, experiments, and scientific growth. It is an open-ended exercise with few constraints. The portfolio is usually in journal format, but it may be in any format the student wishes. Depending on a student’s experience and confidence level, some portfolio entries are relatively simple while other examples are quite sophisticated. Each portfolio becomes unique as students pursue their own interests.

Because this assignment challenges students to think in very different ways, they need significant guidance and encouragement throughout the process. Confidence levels are often low in the beginning. Students do not have experience making their own scientific observations, developing their own hypotheses, or designing their own experiments. They are often afraid of being wrong, thus inhibiting the scientific discovery process. To help students with their portfolios, examples of previous portfolio entries are provided. When students ask questions in class, they are prompted to develop their own hypotheses before the instructor provides an answer. Students have individual mid-term conferences where we discuss their portfolio entries. Later in the semester, students provide constructive feedback on a hypothetical portfolio presented by the



Photo by David Baker

instructor. They share their portfolios with other students to generate new ideas, and they complete self-assessment forms twice a semester to help monitor their scientific growth.

We use multiple evaluation techniques to assess the effectiveness of Scientific Inquiry Portfolios. The first evaluation tool is the portfolio itself. Student portfolio entries generally improve in quality over the semester. The portfolio documents this scientific growth in areas of scientific recognition, use of the scientific method, and scientific attitudes (including relevance, difficulty, and enjoyment). A rubric also has been developed to assess this growth. Second, we use pre- and post-surveys to assess changes in student scientific attitudes and in student confidence levels in their ability to do science. Finally, we have used focus-group interviews to understand student perceptions of the portfolio process.

These assessments indicate that Scientific Inquiry Portfolios are quite effective in helping students recognize science in their everyday lives, in improving student confidence levels in their ability to do science, and in making science more rewarding and fun. Perhaps the best evidence comes from the students themselves:

“Science is beginning to get fascinating for me now. The first few portfolio entries seemed boring because I felt I had to do them for a grade. The last few were fun, and the thought of a grade never crossed my mind.”

“This portfolio has caused me to think deeper...I am not satisfied with simple answers and am finding myself asking many questions.”

“After starting this portfolio, I realized it is fun to try to figure out things myself ...it feels like I am following the ways of great scientists.”

For more information about Scientific Inquiry Portfolios, visit the ESSE Evaluation Toolkit site.

<http://essedesignguide/evaluationtoolkit.html>

ESS at Austin College

http://esse21.usra.edu/ESSE21/esse21_austin.html