



Incorporating Inquiry into Upper-Level Undergraduate Homework Assignments: The Mini-Journal

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The US National Science Education Standards (2000) state that science should be taught through inquiry. The five essential features of classroom inquiry are that the learner (i) engages in scientifically oriented questions, (ii) gives priority to evidence in responding to questions, (iii) formulates explanations from evidence, (iv) connects explanations to scientific knowledge, and (v) communicates and justifies explanations. One difficulty in achieving this vision at the university level lies in the common perception that inquiry be fully open and unstructured, and that its implementation will be impractical due to time and material constraints. In an NSF-funded project, “CUES: Connecting Undergraduates to the Enterprise of Science,” faculty developed new inquiry-based laboratory curriculum materials using a “mini-journal” approach, which is designed as an alternative to the cookbook laboratory and represents the way that scientists do science. Here we adapt this approach to a homework assignment in an upper-level Planetary Science class, and show that inquiry is achievable in this setting.

Traditional homeworks in this class consisted of problem sets requiring algebraic manipulation, computation, and in most cases an appraisal of the result. Longer questions are broken down into chunks worth 1 to 4 points. In contrast, the mini-journal is a short article that is modeled in the way that scientists do and report science. It includes a title, abstract, introduction (with clear statement of the problem to be tackled), a description of the methods, results (presented as both tables and graphs), a discussion (with suggestions for future work) and a list of cited work. Students devise their research questions and hypothesis from the paper based on a logical next step in the investigation. Guiding questions in the discussion can assist the students (“it would be interesting to evaluate the effect of ...”). Students submit their own minijournal, using the same journal-style format. A detailed grading rubric was supplied with the mini-journal, with credit given for formatting, accuracy of calculation, and quality of interpretation and discussion. In the examples we present, research is conducted via spreadsheet modeling, where the students develop their own spreadsheets.

The key differences between the old and new formats include (i) the active participation of the students in defining the problem that they will pursue, (ii) the open-ended nature of the inquiry, such that students need to recognize when they have enough information to answer their question, (iii) presentation of results in graphical and tabular formats, and (iv) a written discussion of their findings.

Based on detailed student and instructor feedback, our conclusions are:

- (i) Limited inquiry is achievable in upper-level science homework assignments, and is transferable to other topics and classes
- (ii) Students experience discomfort on being presented with an open-ended assignment, but like the freedom to define their own homework problem
- (iii) Students recognize that the reading, writing and critical thinking skills employed in the minijournal format increase their understanding
- (iv) Students suggest a combination of minijournal and traditional homework formats in this class, or replacing midterm exams with minijournals
- (v) Student written comments are far more useful than Likert scale responses in assessing instructional techniques and effectiveness