

## **Open Beginning Projects: A flexible approach to encouraging student curiosity and creativity**

**S. Scott Moor  
Lafayette College**

### Abstract

In the rush to fulfill all that they must do, our students often find little time or encouragement to indulge their curiosity. To encourage curiosity, to allow for the diversity of our students tastes and abilities, and to allow for creativity, I introduced a flexible system of small student defined projects. In addition to being open-ended, these projects are open at the very beginning. Students are given the option of defining projects involving any topic related in the course. These projects include experimental studies, the creation of demonstrations for K-12 students on concepts from the course, the reviewing of literature articles, and the presentation of short lectures. The exact project definition and point value is negotiated before the projects are begun. Projects are either deemed complete and the full point value awarded or they are returned for further work. They are due approximately four weeks before the end of the term to allow them to be returned for additional work if necessary. In this presentation I review the details of the set up and results of this approach for a Chemical Engineering Kinetics Class. In addition I will explain the key goals and how well they were met. I found that the key to the success of this effort was providing the students with a long list of possible example projects and their point value. The resulting projects are sometimes just the necessary work to fulfill a requirement but many times they show great creativity and insight.

### I. Introduction

I began using open beginning projects in our senior course in equilibrium and kinetics for several reasons. My goals were: (1) to encourage students curiosity, (2) to recognize the diversity of our students desires and interests, (3) to encourage, particularly our top students, to address more challenging problems, (4) to allow these seniors to order their own work and (5) to encourage completion of quality work to an engineering standard (rather than grading on a curve). This effort began several years ago and has been refined over the years.

### II. Approach

The basic approach is to allow students to design their own small projects with a wide range of possible tasks and point values. Students propose a project area and I help them define the project and the point value for the project. One project point was worth the equivalent of 1% in their final grade. Points were given for project "size" and for original or creative content. I pointed out to students that they would receive the most credit for their effort if they chose creative rather than obvious projects. Students could complete as many small projects as they liked up to a total of ten points. All other portions of the course added up to 95%. Thus students

could actually earn up to 5% extra-credit with these projects. Projects were either deemed of a professional standard and the full agreed upon points were given or they were commented on and returned for revision. The final due date for projects was several weeks before the end of the term to allow time for review, revision and resubmission as necessary.

A wide diversity of projects was encouraged. Figure 1 is a reprint of the list of potential projects

**Figure 1:** Class handout listing ideas for projects

**Some project possibilities** and the usual point values are shown after each project. Actual project point values will vary according to amount of effort and creativity required. The greater the student involvement in creating the project the more it will be worth. Point values should be discussed with me before projects begin.

Demonstrations

- for class illustrating a key concept (5)
- for children illustrating reaction rates (5)

Experiments

- determine rate expression for a simple reaction (4)
- determine the activation energy for a simple reaction or process (4)

Exploring some area of kinetics

- review texts and/or review articles on the area and prepare a brief talk for the class (4-5)
- prepare a brief paper on the subject (4-5)

Review original literature on kinetics or reactor design

- review a research article from the last five years with a memo use questions at the end of chapter 3 of Fogler<sup>1</sup>(3)
- do a kenshu<sup>1</sup> (present a literature article as though you are the author) (4)
- answer one of the article review questions at the end of chapter 4 of Fogler<sup>2</sup>(2)
- attend a research presentation and submit a review memo (1-2)

Solve a specific problem

- solve occasional problems with homework (1)
- do one of the open-ended problems from text supplement<sup>3</sup> (3-4)
- complete one of the problems in Fogler<sup>2</sup> requiring a numerical solution (1-2)

**Some Possible Subject Areas**

- Reaction mechanisms
- Reactor design / unique reactor set ups
- Reactor economics
- Perfect mixing in reactors
- Design of rate experiments
- Analysis of rate experiments
- Topics from any section of Fogler<sup>2</sup>
- Reaction kinetics for some system
- Solution techniques
- Reactor modeling

which I handed out for the Equilibrium and Kinetics Class. Projects could be practical or theoretical, small or large, individual or group. They could be lab work, library research, calculation etc. The resulting projects were not only open-ended but also open-beginning.

### III. Results

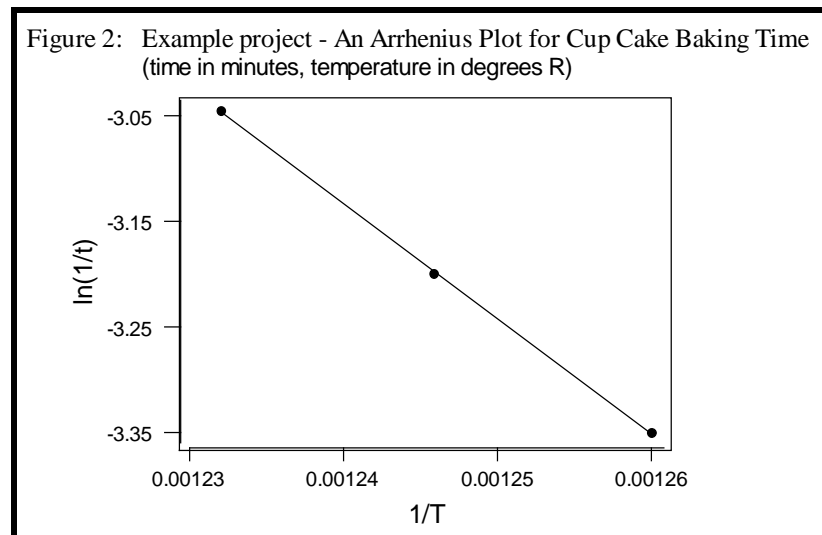
In the most recent class completing these projects there were nineteen students. They completed a total of twenty-three projects. Eight of these were group projects; The remaining fourteen were individual projects. Only two students chose not to complete a project. The types of projects completed are shown in Table 1 below

Table 1: Projects completed in most recent class

Project type	Number of Projects
Article Reviews	6
Presentation Reviews	5
New Experiments Developed and Run	4
Open-Ended Problems from supplement to Foglers text <sup>2</sup>	2
New Classroom Demonstrations Developed	2
Literature Review of Specific Topics	2
Class Presentation of Textbook Material	1
K-12 Presentation and Demonstration Developed	1

The most common projects were the article and presentation reviews. Many students found them the “safest” projects. While not the most creative option, they did allow students to explore their own interests. Most of the remaining projects were very creative and unique projects.

In one experiment a student determined the activation energy for baking muffins. Baking time was defined based on when the tops of the muffins turned brown. She did a careful experiment checking the consistency of the oven temperature with a secondary thermister. Figure 2 shows her Arrhenius plot for this experiment.



In another project, a group of two students designed the equipment and procedures for measuring the decomposition rate of a thioacetamide. They designed equipment that would measure the quantity of H<sub>2</sub>S gas evolved from the breakdown of thioacetamide using a soap bubble flow meter. They derived equations to relate change in gas volume to extent of reaction and reactant concentrations.

Another group of two students developed a demonstration of kinetic principles aimed at grades 5 and 6. They completed a lesson plan for a one-hour session. Their plan included discussions of reactions in every day life, simple experiments and activities. In a second project this same group of two developed a classroom demonstration of the dependence of reaction rate on temperature using the simple vinegar and baking soda reaction.

#### IV. Comments and Conclusion

Students are not completely comfortable with such a wide-open assignment. They are not sure what to expect. An example list of projects, as presented in Figure 1, was essential to improving student acceptance of these projects. In addition, the additional student understanding of what was expected leads to better projects.

It is important to recognize that the particular set up presented here was designed for our setting at Lafayette College, where we have small classes and a high level of student-instructor interaction. For a setting with larger class, it would be necessary to define the assignment further, or the instructor time requirements could become unmanageable. In the future, I will probably make the projects worth more points.

These projects did succeed in encouraging student curiosity. While several students opted for the more straightforward literature reviews, many students were inspired and ventured into very interesting and creative projects. The resulting projects were very diverse – nineteen students completed eight different types of projects with few related topics. Most students ventured into new areas and were challenged by the projects. Top students were particularly affected, as it was nearly impossible to get an A in the course with out completing a significant project. Student defined projects that I had not imagined.

#### Bibliography

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3. Fogler, H. Scott and LeBlanc, S. E. Open-ended Problems in Chemical Reaction Engineering, Prentice Hall, 1995.

#### SCOTT MOOR

S. Scott Moor is an Assistant Professor of Chemical Engineering at Lafayette College. He received a B.S. and M.S. in Chemical Engineering from M.I.T. After over a decade in industry he returned to Academia at University of California at Berkeley where he received a Ph.D. in Chemical Engineering and an M.A. in Statistics. He is a registered Professional Chemical Engineer in the State of California.