How Many Are Too Many? Managing OnLine Growing Pains

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Abstract: The Physical Chemistry OnLine Consortium (PCOL) is dedicated to enhancing undergraduate physical chemistry by encouraging faculty and challenging students to conduct short-term (~4 weeks) Web-based, mathematically sophisticated activities. PCOL projects involve students and faculty at geographically dispersed institutions. In the fall of 2000, PCOL sponsored three very different projects involving faculty and 175 students from 16 different institutions. This paper discusses strategies for dealing with the growing pains that our successful Web-based educational endeavor has encountered.

[††]Introduction

Since August of 1996, when it was founded by four faculty at an informal meeting convened by Theresa Zielinski, the Physical Chemistry OnLine Consortium (PCOL) has endeavored to support a sophisticated approach to teaching and learning in the undergraduate physical chemistry classroom. The consortium provides participating faculty with moral support for experimenting with innovative pedagogical approaches and technical expertise in the variety of subfields that comprise modern physical chemistry. It uses resources that are available to even small chemistry programs with limited budgets. It provides student participants with an opportunity to exchange ideas with a broad spectrum of colleagues, learn to use symbolic math software packages, and develop the online communication skills that play an increasingly important role in today's scientific community.

PCOL projects are presented in a guided, not directed, format. The activities require students to perform and/or analyze physical chemistry experiments and write about the sophisticated concepts and mathematical approaches they utilize. Early projects required students to use a Web site (http://pcol.ch.iup.edu) as a reference source, employed MathCad to support mathematical calculations, and required subscription to a list server to allow interinstitutional peer communication and remote faculty facilitation. Over several semesters, we devised successful strategies for fostering discussion among our student participants, and saw several projects come to successful conclusions. Specifically, we determined that our most successful projects resulted from the following scenario:

- One faculty member acted as primary facilitator, local faculty deferred to "the list" on content and procedural and conceptual questions from students.
- Students worked in cooperative groups at their home institutions.
- Student groups were specifically partnered with student groups from other institutions to form cohorts.
- Students had some familiarity with Mathcad before the projects began.
- Projects were broken into segments and not presented as a monolithic question.
- "Social glue" among groups in a cohort was developed by initiating the projects with low risk "what do you think about…?" questions for discussion.

The growth of the consortium, from one project involving four faculty and 30 students in the fall of 1996 to three projects involving 16 faculty and 175 students in the fall of 2000, led to increasing student complaints about the volume of email associated with the projects. The complaints, along with the consortium's desire to archive student communications in a central location, and the increasing sophistication of Web resources, led us to switch, in 2000, to a Web-based discussion board to support student communication. The pedagogical consequences of the shift in format were nontrivial.

A collaborative action-research analysis of the projects has been conducted. Each discussion-archive entry was coded as to whether it was original, first follow-up, second follow-up, or third or higher follow-up. Our goal in the consortium is to observe both a high percentage of original postings from the student groups and some depth of conversation as reflected by a high percentage of third and higher follow-ups. Our most successful list server mediated project was "The Thermodynamics of Bungee Jumping" in the Fall of 1997. The analysis showed that students began new threads in the conversation five times as often as the faculty facilitator did in this project. The depth of the conversations was enhanced by the incorporation of open-ended questions about elasticity and requirements that student groups peer review each other's work. In the fall of 2000, three projects, not including the Bungee project, were conducted using Web-based discussion

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boards rather than a list server to support student conversations.

The first project required students to analyze the Chapman cycle, describing the oxygen-only kinetics relevant to understanding stratospheric ozone concentrations. Very little discussion occurred within the six cohorts (groups from two schools were paired to form each cohort). Two of the six cohorts had no third or higher follow-ups. Many student questions went unanswered. Finally, one cohort, who had developed the most significant discussion thread, arranged to meet in a chat room for a synchronous discussion of the project.

The second project was a modified presentation of the traditional physical chemistry experiment analyzing the gas-phase visible absorption spectrum of iodine vapor to extract information about the ground- and first-excited-state potential energy surfaces. Despite the participation of a very experienced facilitator, only one of four cohorts produced a discussion in which more than 10% of the postings were second or higher follow-ups.

The third discussion-board-based project required calculation of adiabatic flame temperatures. This project included a component in which student cohorts were asked to agree on the adiabatic flame temperature for the combustion of methane, which we expected would produce significant extended discussions. Students were also asked to determine the flame temperatures of sets of fuels and discuss the results. We anticipated that this feature would lead to extended student discussions;. however, analysis of the transcripts showed that students never came to consensus on the methane flame temperature. Furthermore, more than 50% of the postings were original messages and less than 25% were third or higher follow-ups. Most of the postings were student responses to direct facilitator questions, and very little student discussion was observed.

In evaluating the fall 2000 projects, the participating faculty concluded that the switch from list server to discussion board had reduced the invasiveness of the projects. Students no longer had a flurry of physical-chemistry-related emails in their in boxes every day. As a result, we observed a reduction in both the frequency of, and level of interaction in, student postings. Instead of the substantially student-directed discussions we had observed in the list-server implementations, the Web-based discussion board produced a disjointed series of postings, and did not promote student discussion of the discrepancies in their postings. Consequently, students in the Web-board-mediated projects made less progress, demonstrated a less sophisticated understanding of the problems, and reaped fewer benefits from participation in a learning community than students who participated in the list-server-mediated projects had. For a variety of administrative reasons, however, the consortium has decided to maintain the Web-based discussion board format. We are, therefore, pondering two modifications to our modus operandi. We hope these changes will restore the higher-level learning and interaction we had observed in earlier projects.

The invasive presence of email seems to have aided in the high achievement noted in our best list-server-mediated projects. Students, if they are to be successful in these challenging projects, cannot be allowed to avoid thinking about them between scheduled classes or laboratory sessions. One option would be that local faculty remain actively involved in the process and no longer defer to the online discussion and remote faculty moderator to deal with content and procedural or conceptual questions. Next semester, however, we will attempt to reduce the percentage of "answer the question" responses in another way. Faculty facilitators will send regular, perhaps daily, emails to the student participants, even though the student cohorts will be communicating via Web-board. We anticipate that more frequent facilitator interaction will improve cohort participation and student achievement.

As always, we are learning from our students. When students in the fall 2000 implementation of the ozone kinetics project organized a chat session to consider a particularly vexing point, we paid attention. A second change for next fall will be to schedule some "chats," with an eye towards bringing the students to consensus several times during the projects. Designation of specific consensus points will be a new feature. We anticipate that demanding consensus at several points will motivate the students to investigate the discrepancies among their initial responses and, therefore, consider the scientifically interesting details that underlie them. This should produce student conversations with more third-level or higher follow-up postings and promote the higher-level learning we espouse.

Our consortium's growth, coupled with the essentially universal improvement in access to computers and Web-based resources, has considerably broadened the scope of projects we undertake. Constant improvements in technology have also meant that what worked last year may not work this year. The benefits of collegial faculty interaction for developing strategies to address the continually changing problems presented when using technology to enhance undergraduate teaching and learning cannot be overestimated. We are delighted to have had the opportunity to present this status report on our work at this symposium on Web-Assisted Learning in Chemistry.

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