Are We Serious about Preparing Chemists for the 21st Century Workplace or Are We Just Teaching Chemistry?

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What Characteristics of Employees Do You Value in Your Workplace?

In 1998, Hamline University's Science Division asked this question of 16 managers representing as many Minnesota-based industries. Managers invited to luncheon meetings represented a variety of companies ranging from small medical product start-ups to Fortune 500 organizations like 3M. Science Division faculty and the assistant dean for the College of Liberal Arts also participated in these luncheon meetings. Invited guests vigorously responded to the question and provided 16 "valued characteristics" (List 1). The answers were revealing but disturbing. "We need competent scientists who also have cultural competencies, excellent communication skills, and a knowledge of how for-profit organizations function. We also need scientists who have the ability to work with others within interdisciplinary problem-solving teams. We need scientists who have data-analysis skills, a passion for life and learning, good work ethics, maturity and a broad background with the ability to move effortlessly from science to business to humanitarian issues." We asked if these valued characteristics influence the hiring process. Our guests assured us that evidence of these skills is an important consideration in the hiring process. The industrial managers urged us to have students prepare portfolios that demonstrate or document their skills and extracurricular activities. We were surprised that GPA, even GPA in chemistry, seemed to be of less interest.

Evidence that she or he:

1. Possesses cultural competencies
2. Communicates well (written, oral, computer)
3. Exemplifies a strong work ethic: is a "self-starter", an independent learner with an entrepreneurial attitude
4. Demonstrates proven team-working abilities and knowledge of group dynamics: possesses interpersonal skills and flexibility
5. Presents a reflective and aware attitude (what is wanted in life: how education, interests, and work can and should mesh)
6. Understands how for-profit organizations function
7. Exhibits passion and enthusiasm
8. Demonstrates technical and intellectual ability
9. Has successfully completed an internship in the nonacademic workplace
10. Participates in volunteer or extra-curricular activities
11. Provides evidence of a broad-based education
12. Demonstrates competence in problem solving and critical thinking
13. Shows leadership qualities and conflict resolution experience
14. Possesses computer-based quantitative data-analysis skills
15. Actively pursues further education or training
16. Presents a mature, responsible, and productive outlook

List 1. Sixteen valued characteristics in the nonacademic workplace.

Answers to the question provided by representatives of the technological workplace were (and continue to be) disturbing because the Hamline University Science Division curricula had been focused on preparing students for entrance to the best graduate and professional schools in the country. Most of the 16 valued characteristics outlined by industrial managers were *not* used as entrance criteria by graduate or professional schools and, therefore, were not part of our departmental curricular concerns. Thus, our science curricula were designed to prepare students for careers in academe but *not* for professions in the nonacademic workplace. The answers were the more disturbing when we discovered that (i) 75–85% of our graduates seek and find employment in the nonacademic workplace and (ii) most science faculty members had no significant experience in or contact with the industrial workplace.

Did We Discover Anything New from Our Meetings with Industry Leaders?

A search of the literature revealed that for at least a decade, industrial and academic leaders have been calling for changes in science curricula to better prepare students for the nonacademic workplace *(1–3)*. Changes suggested by these industrial leaders paralleled the responses of our luncheon guests. A search of the literature in the area of science and chemical education revealed many examples of how to improve, or expand technical courses and laboratories *(4, 5)*. However, we found only a few references indicating a concern for the role and importance of the liberal arts in the education of scientists *(4, 6, 7)*.

Our experiences coupled with those found in the literature indicated that college faculty members either were unaware of or insensitive to the expectations and challenges of the 21st century technological workplace. As mentors of students who will eventually seek employment in the nonacademic workplace, we were forced to ask the question:

> Do we just teach chemistry or do we have a responsibility for helping students prepare for the expectations and challenges of the modern technological workplace?

This question prompted us to submit a proposal to the National Science Foundation to support a liaison between Hamline University and the 3M Company for the purpose of developing models for better preparing science students for the 21st century workplace.

Project Execution

Teams

Five Curricular Development Teams (CDT) were at the heart of the Hamline University–3M Project. Three other programs (Student and Faculty Internships at 3M and 3M Professionals in the Classroom) were designed to buttress the work of CDT (five faculty members and 15 students participated in 3M internships). Each CDT consisted of four faculty members (at least one from a nonscience area), two students, and at least two 3M professionals. Each team had a focused curricular goal (List 2). Each team met regularly (one or more times a month) during the three-year period and two teams also met during summer months. During years two and three of the grant period each team received team skill-development training. Each team designed and initiated one or more teaching–learning models for achieving its assigned goal. On each team 3M professionals played key roles and exhibited strong leadership.

Assignments

During the first year, all teams were ineffective. Team members continued to function in an academic committee format, that is a chair who did most of the work, a lack of shared goals, a forum for unbridled expression of opinion, and so forth. By the end of the first grant year, three teams had accomplished little and two teams were completely dysfunctional. Faculty did not understand the difference between "committee", "task force", and "team". Surprisingly, it was two 3M student interns that convinced Team 4 (Team Problem-Solving) members that Hamline University was a committee-based society and *not* a team-oriented community. These student interns convinced Team 4 members that Hamline University faculty did *not* understand how an interdisciplinary team functions nor the power and potential of a well functioning team. At the urging of 3M members of Team 4 we engaged a consultant to help a small group of Hamline University faculty members (15 people) enhance their team problem-solving skills. Some of these faculty members then became "coaches" to help CDT develop team skills. The results were amazing. CDTs went from dysfunctional to highly effective. Teams adopted systems that included, for example, (i) rotating "facilitators" and "recorders", (ii) methods for focusing time based agendas on shared goals, and (iii) methods that limited comments, concerns, or ideas of team members to short periods of time (1 to 2 minutes), For more details see Hamline-3M Project Web site *(8).*

Team 1:	Develop strategies and initiate programs to improve student and faculty communication skills.
Team 2:	Develop strategies and initiate programs to: (i) improve efficiency and effectiveness of technical courses and (ii) incorporate new topics that are important in industry into courses or laboratories.
Team 3:	Develop strategies and initiate programs to improve student understanding of for-profit organizations.
Team 4:	Develop strategies and initiate programs to improve student and faculty team problem-solving skills.
Team 5:	Develop strategies and initiate programs to improve student and faculty understanding of the importance of cultural competencies in the 21st century nonacademic workplace.

List 2. Five teams of the Hamline University–3M Project.

What Did the CDTs Accomplish?

Each CDT designed and initiated substantive programs within their assigned area. A few selected examples of achievements are listed below:

- Speaking and writing competitions and other communication activities within the Science Division
- A new course for science students within the business–economics department, developed with help of 3M professionals
- A new course within the Conflict Resolution Program developed with help of 3M professionals
- New tutorial approaches for general chemistry and physics
- Culture competency workshops for science students
- Team problem-solving workshops for faculty
- Data-analysis tutorials for students in all science departments

A more complete list of activities and outcomes is available at the Hamline-3M Project Web site (*8;* see also ref *9*).

What Did the Hamline University–3M Project Demonstrate?

The project developed the following:

- A model of an effective academic–industrial curricular development liaison
- A model for efficiently and effectively utilizing interdisciplinary academic–industrial curricular development teams to improve science education
- A model for utilizing the industrial intellectual community to enhance undergraduate science education and, at the same time, developing mutual respect and understanding between academic and industrial professionals

- Two new courses in nonscience areas for science students that were developed through the coordinated efforts of faculty and industrial professionals
- A model for developing greater understanding and mutual respect by the entire college community for initiatives of the Science Division and of the industrial professionals who helped shape these initiatives.
- A liaison model that catalyzed and supported other related campus-wide programs and introduced a new perspective of the potentials of and possibilities for the college
- A mechanism by which professionals from industry could effectively illuminate the challenges and expectations of the 21st century workplace for students and both science and nonscience faculty
- A model of how leadership and expertise provided by industrial professionals can help faculty develop and implement new curricular models and also provide a better understanding of the modern technology-intensive workplace not possible within academe alone

Conclusion

So, are we just going to teach chemistry? Do we expect our graduates to spend their professional careers only at the bench? As mentors do we have a responsibility to take a new look at the chemistry curricula in light of the challenges and expectations of the 21st century workplace? We think the answers to these questions are important. Every academician has the responsibility of answering these questions and, more importantly, implementing a program to prepare chemists for the 21st century.

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