Critical Issues and Effective Practices in Chemistry-Based Laboratory Technology Education

A Report from the ChemTechLinks Conference 2004 and a National Survey of Chemistry-Based Laboratory Technology Programs

March 2006

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OVERVIEW

The critical issues and effective practices in chemistry-based laboratory technology education constituted the focus of the ChemTechLinks Conference 2004 and a subsequent survey of laboratory programs across the country. The American Chemical Society's ChemTechLinks project, supported by the National Science Foundation Advanced Technological Education Program, sponsored and organized both the conference and survey as part of its mission to support chemistry-based technology education.

At the ChemTechLinks Conference 2004, leaders from industry, academia, and government participated in discussions organized to

- identify critical issues facing chemistry-based laboratory technology education,
- explore factors influencing or driving these issues,
- discuss effective practices for addressing these factors, and
- develop model implementation plans for selected practices.

As a result of the discussions, participants identified what they believed to be the most critical issues facing laboratory technology education, as follows:

- alliances among industry, academia, community, and government;
- recruitment, retention, and placement;
- national curriculum benchmarks and graduate skills assessment;
- faculty resources;
- incorporating updated technology and relevant subject matter into curricula;
- community awareness of the chemical technology profession;
- employability skills;
- relationships to grades K–16; and
- industrial experiential learning opportunities.

The top seven of these critical issues provided the framework for conference breakout discussions on causative factors and potential effective practices for addressing them.

All nine critical issues were explored further in a survey of chemistry-based laboratory technology programs. Conducted in 2005, the survey was sent to all known programs. The results brought additional insight into the current state of education programs.

The outcomes of this conference, combined with the survey results, can serve as an important reference for chemical technology programs across the nation, providing a broader perspective to which local issues can be compared. The participants also identified a number of practices that may be helpful in addressing the issues that face many of the institutions involved in recruiting, training, and employing chemical laboratory technicians. ●

INTRODUCTION

Establishing and maintaining strong academic programs requires resources. This is particularly true for science programs at two-year colleges. The mission of ChemTechLinks, a project of the American Chemical Society, is to support chemistry-based technology programs. Along with resources to assist with curriculum development and outreach, ChemTechLinks has focused on providing insights into how to build programs that are effective and responsive to industry needs. The goals of the ChemTechLinks Conference 2004: Critical Issues and Effective Practices in Chemistry-Based Laboratory Technology Education and the subsequent survey conducted in 2005 were to examine the current state of chemistry-based laboratory technology programs, determine the areas of greatest need, and identify practices that could be adapted by others. Support for the conference and survey were provided by the National Science Foundation Advanced Technological Education Program.

ChemTechLinks organized the conference and survey to complement the series of Critical Issues and Best Practices in Process Technology Education conferences organized by the Center for the Advancement of Process Technology (CAPT). The goal of the conferences has been to provide an opportunity for educators and industry to meet, share viewpoints, discuss problem areas, and collaborate on practices that will improve the way process technology is taught. ChemTechLinks sought to mirror the success of these conferences by holding a similar one focused on chemical laboratory technology education.

Conference Agenda

The ChemTechLinks Conference 2004: Critical Issues and Effective Practices in Chemistry-Based Laboratory Technology Education was held July 16–18, just prior to the 18th Biennial Conference on Chemical Education in Ames, IA. Twenty-seven participants came from two-year colleges and high schools, industry, and government agencies (see Appendix I). The agenda consisted of an opening plenary and a day and a half of working sessions (see Appendix II).

William Carroll, then ACS President-Elect, gave the opening plenary speech. His remarks focused on the changing nature of the chemical enterprise.

The conference itself was organized into four working sessions. The first one pursued the goal of identifying the most important or critical issues affecting technician education. In the second, participants identified what they believed to be some of the underlying or causative factors influencing these critical issues. During the third session, conferees brainstormed about potential effective practices to mitigate these causative factors. Participants used the fourth session to develop a few of these effective practices into more detailed implementation plans, which elaborated some of the steps that programs might follow in using the practices to foster improvement.

Capturing Participant Input

Technology played a central role in organizing the input from the participants and reaching consensus about the relative importance of various ideas. During the conference, a linked system of computers gathered, reviewed, and organized input.

Groups of two or three conferees each received a laptop computer linked through a wireless connection to a central server. The system allowed everyone to exchange, prioritize, and provide feedback on participant input during the initial round of brainstorming and subsequent discussions quite successfully (see Appendix III for the postconference evaluation of this technology and other aspects of the meeting). CoVision Inc. provided the technology and hardware.

Identifying Critical Issues

To ensure adequate time for discussion, the organizers gathered initial input on the critical issues beforehand. Preregistering attendees were polled to see what they considered the three most important issues relative to chemical lab technology education programs. Their initial suggestions provided 10 items. The entire group of conference participants received this list of items in one of the opening sessions. Allowed to identify additional items, conferees ultimately identified a total of 13 critical issues.

During the process of prioritizing this list of 13 to determine which 7 to discuss during the rest of the conference, the group combined several related issues, creating a list of 9. Each group received the total list of 9 issues on its laptop and chose the ones they felt were most important. The subsequent ranking defined the 9 critical issues listed in Table I. The top 7 constituted the focus of the remaining conference sessions, but the survey conducted in 2005 explored all 9 issues.

TABLE I

Critical Issues in Chemistry-Based Laboratory Technology Education

1. Alliances among industry, academia, community, and government
2. Recruitment, retention, and placement
3. National curriculum benchmarks and graduate skills assessments
4. Faculty resources
5. Incorporating updated technology and relevant subject matter into curricula
6. Community awareness of the chemical technology profession
7. Employability skills
8. Relationships to grades K–16
9. Industrial experiential learning opportunities

Identifying Causative Factors

In order to address critical issues, the underlying causes must be identified. To capture the range of perspectives from different stakeholders and programs, all participants provided causative factors for each of the critical issues. The causative factors were not ranked, but participants reviewed and provided feedback on each other's contributions.

Identifying Effective Practices

During this session of the conference, participants shared approaches that they had found effective, as well as ideas for practices that would address the causative factors. Please note that the effective practices recorded in the report reflect the expertise and experience of the participants, but do not necessarily reflect practices validated by research or proven effective by data. Additionally, please note that this report includes all of the input from the participants except that culled as a result of discussions and rankings at the conference.

Drafting Implementation Plans

Once the participants identified the issues, causative factors, and effective practices, they reorganized into larger groups to consider some of the effective practices in greater detail. The organizers targeted these groups' composition somewhat more, assigning participants on the basis of their past activities. Each of the groups received a model implementation plan (see Appendix IV) and a common set of features to cover in their plan:

Goals | **Sources of Income**
Partners | **Timeline**
Possible Activities | **Assessment**
Expenses

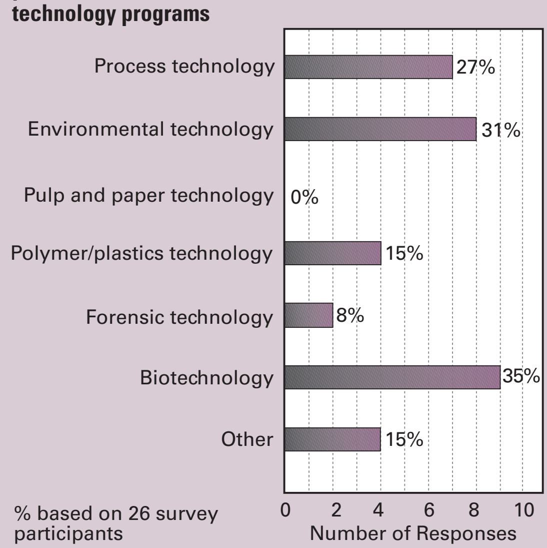
The groups developed a total of eight of these plans, each showing a wide range of breadth and detail. Many plans included elements that various programs had implemented. Some featured aspects that have yet to be tried. The groups developed the plans, and presented each one to the entire group. The conferees then added additional suggestions and helped clarify the various elements of the plans. By no means comprehensive, these implementation plans help point the way for institutions planning activities relevant to the critical issues facing chemical laboratory technology education programs, providing frameworks that can be adapted and filled in to best fit the local situation.

Exploring the Critical Issues Further

The following sections of this report present the results of the conference discussions, which are organized around the critical issues the participants identified. This leads to a larger question: Do the critical issues that the Critical Issues and Effective Practices conference participants identified truly represent the issues that educators across the nation consider critical to their programs?

FIGURE 1

Percentage of chemistry-based laboratory technology programs at institutions offering other chemistry-based technology programs



% based on 26 survey participants

In order to assess the national perspective on these critical issues, ChemTechLinks sent a follow-up survey to 103 chemistry-based laboratory technician education programs around the country. It was structured around the nine critical issues established at the Critical Issues and Effective Practices Conference.

A total of 27 programs responded, including a bachelor's program. Because bachelor's programs significantly differ from the typical certificate or two-year programs, the input from the bachelor's program was not compiled nor included in the data reported.

Of the 26 programs, 13 were established more than 20 years ago and 9 are ACS-approved. Geographically, 11 responded from the northeast, 3 from the Great Lakes area, 2 from the Gulf Coast states, and 2 from the western United States.

Nearly 60% of the chemistry-based laboratory programs responding are found at institutions offering other chemistry-based programs. The types of programs are shown in Figure 1.

This report contains the survey's relevant results, which the authors have added to each critical issue's summary. We hope that as you review the alignment of the information from the conference with that in the follow-up survey sampling, you will find a clearer image of the issues facing chemistry-based laboratory technology education emerging. ●

CRITICAL ISSUE 1

ALLIANCES AMONG INDUSTRY, ACADEMIA, COMMUNITY, AND GOVERNMENT

It is essential to participate in a healthy alliance with industry and other community partners to maintain a successful technician education program. For this reason, taking part in an alliance serves as the primary criterion for ACS approval by the Chemical Technology Program Approval Service. Establishing and maintaining an alliance poses challenges, however, for the many reasons identified below.

Causative Factors

Alliance building is a lengthy and involved process. Unfortunately, members of both academia and industry often have a minimal amount of time available for working together. Limited awareness of the benefits alliances can offer often couples with a lack of established methods for initiating collaborations or working with partners. In such cases, members of the industrial and academic communities rarely feel motivated to work together.

Alliance building is a customized process that reflects specific local needs and industries. Rarely does an established forum exist for sharing concerns. Determining the key personnel to include in the process of building alliances can prove difficult. Who is responsible for initiating the process? Who should be included? Many government agencies and labor and trade organizations have not historically interacted with colleges. Industry supervisors or human resources personnel do not communicate continuously with schools regarding hiring standards for chemical technicians. Most schools do not implement effective faculty and program development. Without an energetic leader or advocate, coupled with a specific program or project—such as cooperative agreements or marketing career opportunities—alliances do not form.

Causative Factors: Ineffective or Non-Existent Alliances

- Members of both academia and industry tend to find very limited time available for building alliances.
- Potential partners often lack awareness of the possibilities alliances can offer.
- Academic programs for training chemical laboratory technicians suffer from insufficient marketing and advertising.
- Industry, academia, communities, and government often lack established methods of initiating or adding partnerships.
- Faculty resists working with industry and vice versa.
- Industry and academia lack established forums for bridging their concerns.
- Determining the key personnel to include in the alliance-building process poses difficulties.
- Government, labor, and trade organizations have not traditionally interacted with colleges.
- Employed technicians, supervisors, and human resources departments lack continuity in their communications regarding hiring standards for chemical laboratory technicians.
- Most schools do not implement effective faculty or program development.
- Industry, academia, and government have not developed cooperative agreements or contracts to pursue common interests in training and educating laboratory technicians.

Potential Effective Practices

The following strategies could be pursued to help address the causative factors of ineffective or non-existent alliances.

- At the highest administrative levels of academia and industry, begin to develop plans to share the benefits of alliances among all parties to be involved.
- Inform potential members about the benefits from the alliance—make a point of including all stakeholders: K–12 programs, government, industry, other community colleges, 4-year institutions, and labor organizations.
- Set up a mechanism for collaboration and for clarifying and documenting roles, expectations, and benefits for alliance members.
- Establish, maintain, and keep available a listing of all parties involved in the alliance.
- Publicize the program within and beyond the alliance.
- Set up mechanisms for the alliance's growth.
- Provide actual working meetings (workshops) rather than presentations.
- Meet regularly, but encourage members to communicate more frequently among themselves. To encourage continuing interaction, develop small, task-oriented groups.
- Allow for additional alliance members. Do not limit membership to original participants.

A more detailed plan for implementing these strategies is on page 5.

The National Perspective on Alliances

Survey results on alliances among industry, academic programs, community, and government provided a relatively positive picture. Some 60% of those programs responding to the survey said they belong to an alliance or partnership. The size and nature of those alliances varied widely. Eight programs had more than 10 partners, most of which were industry partners. Three of the 14 programs with alliances had only 1 industry partner and 3 had none. Five programs had partnerships with at least 1 high school. Eleven programs had partnerships with 4-year colleges and universities. Eight programs had partnerships with workforce organizations.

The kinds of activities the alliances supported reflected to a high degree the causative factors that the conference cited (please see Figure 2). The extent of interaction and collaboration proved more difficult to discern. Half of those involved in alliances or partnerships said the expectations and benefits of their involvement had been documented. When asked how many times meetings or conference calls were held per year with alliance or partner organizations, 56% said 1–2 times and 38% said 3–5 times. The remainder met 6 or more times per year. ●

A Possible Implementation Plan for Building Alliances

Goals:

- Initiate and build an alliance.
- Maintain the alliance actively.

Partners:

- K–12 educators
- Local government
- Industry
- Community colleges
- Other 4-year institutions
- Labor organizations
- Equipment vendors
- Local professional organizations
- Local industrial retirees

Possible Activities:

- Hold exploratory lunch or dinner meetings between the academic program director and local industry management (identify the highest level of representative from the local industry for these meeting).
- Set up and plan the kick-off meeting of the program director and industry representatives (purpose, agenda, location, time, and so on).
- Define the initial list of contacts and invitees (do not limit the possible attendees at this point).
- Present the outline of local laboratory technician education programs and the graduates' capabilities. Identify the benefits to local industry that the alliance will bring. (This is the marketing and sales segment of the plan.)
- Clarify and document roles, expectations, and benefits for alliance members. Stress the benefits the alliance will confer.
- Following the initial presentation, hold sessions to begin identifying the alliance's scope.
- Solicit recommendations for additional alliance members —don't limit membership when taking suggestions.
- Establish, maintain, and keep available a listing of all the parties involved in the alliance, including a listing of schools and chemical technician programs, a list of hiring industries, and a list of job descriptions and responsibilities for both specific and generic positions.
- Solicit feedback for the next steps in developing a strong alliance (use resources from ACS to provide a framework for the feedback).
- Agree to additional tours as part of follow-up activities (these should include tours of both academic program and industry facilities).
- Close each meeting by agreeing on the next meeting of the larger group and any smaller group or subgroups.
- Send a thank you note to each individual who attended.
- Publicize the alliance's activities and success stories.

Expenses:

- Postage for invitations
- Potential charge for facility use
- Refreshments
- Cost for any promotional material
- Time to develop initial large group meeting
- Time of participants

Sources of Income:

- Departmental budget
- Industry donations

Timeline:

- Month 1—Hold exploratory meeting(s) with industry representatives.
- Month 2—Develop contact list and kick-off meeting agenda; set up meeting.
- Month 3—Hold kick-off meeting, mapping out goals and timeline for the next several years.

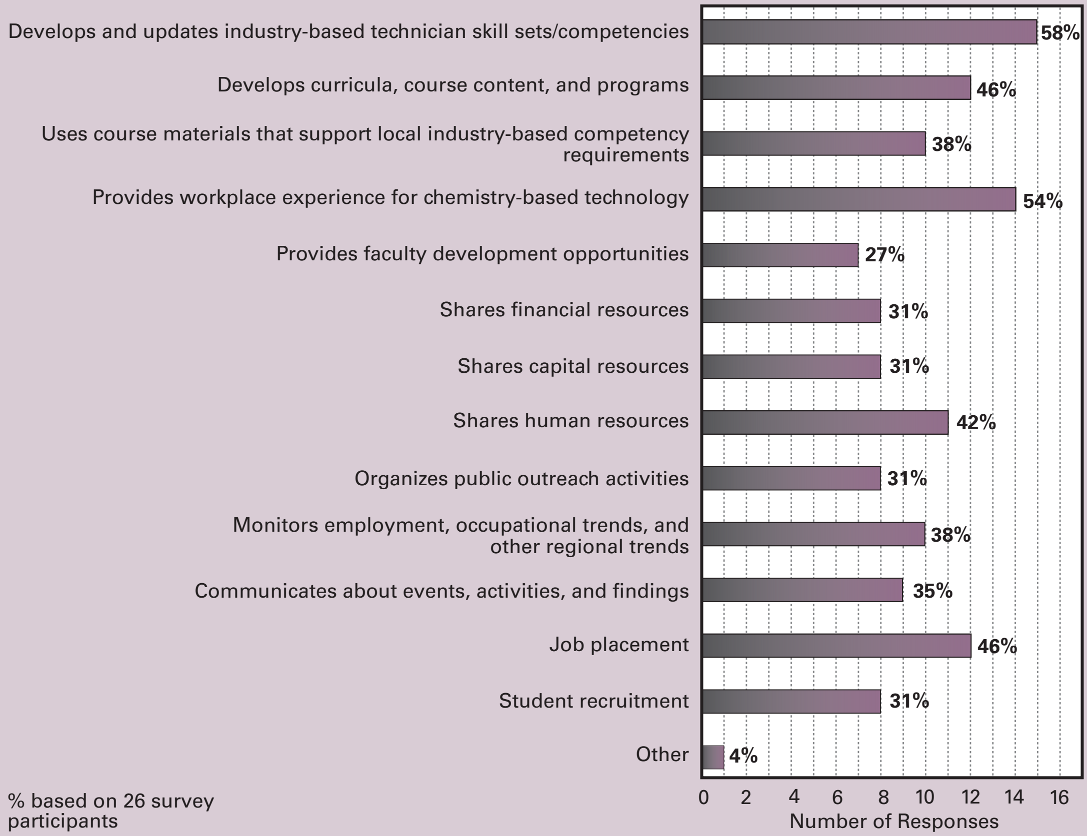
Assessment:

- Track amount of follow-up activity (e.g. continued contacts, participation in follow-up meetings, interactions between students and industry, local publicity for the alliance, etc.).

For more resources on alliance building, contact chemtechlinks@acs.org.

FIGURE 2

Percentage of chemistry-based laboratory technology programs involved with alliance activities



% based on 26 survey participants

CRITICAL ISSUE 2

RECRUITMENT, RETENTION, AND PLACEMENT

Chemical technology programs can only remain viable over time if they are able to recruit, retain, and place students in jobs. When such programs initiate alliances, they must develop and carry out plans for all three functions in conjunction with alliance partners. These plans should address the common barriers identified at the conference.

Causative Factors

Recruitment: The causative factors for low recruitment highlight a need for raising awareness and countering misconceptions held by students, parents, teachers, and counselors. Attracting a sufficient quantity, quality, and diversity of students is a challenge for many chemical technology education programs. Faculty and counselors for grades 7–12 often have a poor-to-nonexistent awareness of chemical technician careers. Further, parents and the general public seem to have a low regard for two-year programs as compared with four-year college and university programs.

Two-year educational institutions offering laboratory technology programs often lack marketing materials that describe programs effectively. Technology education programs make little-to-no special outreach to nontraditional students, such as adults interested in changing careers, or those entering the workforce for the first time. Technology education programs have not developed brochures or other materials to showcase success stories in chemistry technology. Students do not see a clear connection between completing a technology education program and landing a job in industry. They also fear that a two-year degree will limit their future opportunities and often do not know about articulation programs with four-year degree programs or programs for continuing education offered by industry.

Retention: The widespread lack of awareness about careers and the financial realities students face also affect retention. Since industry and academia do not promote career opportunities for chemical technicians, the larger community tends to believe that chemical technician jobs lack prestige and does not recognize technicians as professionals. This can cause students to pursue other areas of study. Degree programs fail to offer sufficient research, co-op, and intern opportunities, which can motivate students and often open doors for employment. Scholarship programs that can alleviate students' financial concerns, such as those offered by ACS for underrepresented populations, receive insufficient publicity.

Placement: Students entering technical education programs want assurances that they will find jobs upon graduation. They may not feel this confidence if academic institutions lack strong articulation agreements with industry. Even where alliances exist, the placement process may only involve alliance members in ways that

Causative Factors: Problems in Recruiting, Retaining, and Placing Chemical Technology Students

Recruitment:

- Faculty and counselors for grades 7–12 have poor-to-nonexistent awareness of chemical technician careers.
- Parents and the general public have a low regard for two-year programs.
- Marketing materials for educational institutions do not describe technology programs effectively.
- Technology education programs make little-to-no special outreach to nontraditional students.
- Technology education programs have not developed brochures or other materials to showcase success stories in chemical technology.
- Career paths to industry and four-year degree programs are not apparent.

Retention:

- Industry and academia do not promote career opportunities for chemical technicians.
- Chemical technicians are not recognized as professionals.
- Degree programs fail to offer sufficient research, co-op, and intern opportunities.
- Scholarship programs for underrepresented populations offered by ACS and others receive insufficient publicity.

Placement:

- Two- and four-year institutions often lack strong articulation agreements with industry.
- The placement process only involves alliance members in ways that are quite weak or nonexistent.
- Technology education programs do not include adequate training in employability skills such as communication, problem solving, positive attitudes and behaviors, adaptability, and working with others.

are weak or ineffective. When technology education programs do not include adequate training in employability skills (such as communication, problem solving, positive attitudes and behaviors, adaptability, and working with others) in addition to science, technology, and mathematics skills, their students are likely to have more difficulty getting a job and succeeding at it.

Potential Effective Practices

The following strategies could be pursued to help address the causative factors of low recruitment, retention, and placement rates.

- Educate the K–16 community and the general public about the chemical technology profession, emphasizing that it is a viable career choice. (See implementation plan below.)
- Establish an advisory committee that includes industry, chemical technicians, teachers, and administrators.
- Prepare materials that showcase success stories to be used at career fairs or to promote career awareness at either high schools or two-year programs.
- Include people in alliances who understand marketing procedures.
- Develop peer groups, mentoring, and job shadowing opportunities to support student success.
- Incorporate a support structure that addresses the needs of nontraditional students.
- Help industries and schools develop and sustain a commitment to each other that includes employment, internships, job shadowing, mentoring, and curriculum building.
- Include professional organizations in developing the

A Possible Implementation Plan for Conducting an Outreach Campaign

Goals:

- Inform students and other identified partners about the educational and career opportunities offered in chemistry-based technology, using real-life success stories.
- Incorporate diversity into the outreach materials to attract nontraditional students and those from underrepresented groups.
- Inform students about successful educational and career pathways.

Partners:

- College and university chemical technology faculty
- Admissions offices
- Alumni associations
- High school chemical technology educators
- Career counselors
- Industry
- ACS Committee on Technician Affairs
- ACS Division of Chemical Technicians
- ACS Technician Affiliate Groups
- ACS local sections
- Various ACS offices, committees, and divisions
- Social service organizations
- Unemployment agencies
- Public relations and marketing firms

Possible Activities:

- Issue press and news releases to local media.
- Educate all parties involved about how to access and use outreach materials and how to direct people to them.
- Inform partners about activities, tailoring the message as appropriate.
- Participate in career fairs, job fairs, community events, and other forums.
- Establish a website.

Expenses:

- Cost of PR firm
- Cost of materials (printing, video production, mailing, etc.)
- Costs associated with participating in career fairs, community events, and other activities (travel expenses, stipends, etc.)

Sources of Income:

- Local and national professional organizations (e.g., ACS local sections)
- Corporate foundations
- Corporate grants
- Social service organization grants
- Local industry

Timeline:

- Generate timeline for completing each activity, task, and job assignment for partners.
- Capture key success stories, materials, and interviews (videotaped, audiotaped, or written).
- Identify funding sources and generate funding applications (corporate sources, admissions offices, alumni associations, professional organizations, and other key partners).
- Identify and develop appropriate PR tools (brochures, videos, press releases) based on available funding and established priorities.
- Educate all partners and the public about the program's availability, how to use materials, where to access materials, and so on.
- Disseminate program materials to identified partners.

Assessment:

- Track enrollment numbers and demographics.
- Track website hits.
- Survey students to identify how they obtained program information and what method or materials they found most valuable or useful.
- Track contacts made with individuals identified as success stories.
- Track media coverage obtained (print, broadcast).

curriculum, in creating marketing materials and articu lation agreements, and in publicizing the chemical technician profession.

- Increase working relationships among high schools and two- and four-year institutions to develop articulation plans.
- Develop and publicize articulation programs that allow students who complete technology education programs at two-year colleges to continue their educations at four year colleges and universities, thus completing bachelor's or higher degrees. (See implementation plan.)

The National Perspective on Recruiting, Retaining, and Placing Students

In response to the survey question about the number of students in chemistry-based laboratory technology courses, the highest percentage (30%) said 26 or more students were enrolled. The bulk of the remaining responses (59%) cited class sizes ranging from 6 to 25. Several of the programs receiving the survey but not completing it indicated that their programs had been suffering from low enrollments, and in some cases were canceled because of them.

The primary source of new students tended to vary widely from program to program. In 33% of the programs responding, the largest group came directly from high school. However, a significant number of programs cited that nearly all their students came from industry.

More programs graduated students with associate degrees than with certificates. Of the 25 programs responding, 88% had job placement services in place for students. While 70% of the programs had articulation agreements in place for four-year college programs, only 44% had such agreements with industry or high schools. ●

A Possible Implementation Plan for Articulating Chemical Technician Education Programs

Goals:

- Increase working relationships among 7–12 and two- and four-year programs.
- Increase chemical technology students' awareness of their future educational and career opportunities and pathways.
- Develop articulation agreements among various levels of education that include career pathways, specific preparatory course work, skill standards, skill development, etc.

Partners:

- 7–12 programs
- Two- and four-year programs
- Industry
- Professional organizations

Possible Activities:

- Form a committee.
- Research other programs to identify the needs of each academic component (i.e., standards that students must meet, which credits would transfer, what preparatory work the programs require, and so on).
- Develop skills assessment tools.

For more resources on student transfer, visit chemistry.org/education/2year.html

CRITICAL ISSUE 3

NATIONAL CURRICULUM BENCHMARKS AND GRADUATE SKILLS ASSESSMENTS

Successful chemistry-based laboratory technology programs need to demonstrate the quality of their programs and the qualifications of their graduates. To be approved by ACS, chemical technology programs must demonstrate that their curricula are aligned with industry needs. Although the Voluntary Industry Standards are available as a tool (www.chemtechlinks.org/skillstandards), these skill standards are designed to be customized for local industry needs and do not define a national curriculum. Given the variations across the country, comparing curricula and developing common assessment tools becomes more difficult.

Causative Factors:

No national agreement defines the nature of the chemical technicians' profession, nor the educational program for training them. No consensus exists regarding the need for specific national curriculum benchmarks and standards.

Correspondingly, there is no nationally based certification exam for chemical technicians that would prove technical proficiency. Industry has not indicated an interest in hiring certified graduates. As a number of conference participants noted, certification by examination can only be useful if both industry and technicians value it.

Causative Factors: Lack of National Curriculum Benchmarks and Skills Assessments

- No national agreement about the definition of "chemical technician" exists.
- Interested entities have reached no consensus about the need for specific national curriculum benchmarks and standards.
- There is no nationally based certification exam.
- Industry has not expressed a desire for certified laboratory technicians.

Potential Effective Practices

The following strategies could be pursued to help address the factors preventing national benchmarks and skills assessments.

- Disseminate existing national standards that the Chemical Technician Program Approval Service (CTPAS) has developed.
- Highlight the importance of allowing local needs to drive the use of assessment instruments and of industry

A Possible Implementation Plan for Developing and Administering a National Certification Exam for Chemical Technicians

Goal:
- Certify chemical laboratory technicians.

Partners:
- Representatives from industries that use chemical laboratory testing as an integral support function (e.g. chemical commodities, pharmaceuticals, medical, nuclear, and food)
- CTPAS
- ACS Examinations Institute

Possible Activities:
- Increase the number of ACS-approved chemistry-based technology programs.
- Establish certification qualifications.
- Prepare the exam and validation.
- Publicize the announcement of the certification program, its value to the industry, and the merits of this credential for individuals through the ACS Office of Communications and other venues.

Expenses:
- To be determined by the ACS Examinations Institute.

Sources of Income:
- Institutions that give the exams
- Application fees

Timeline:
- Exam should be given semiannually.

Assessment:
- To be provided by ACS Examinations Institute.

participating in designing assessments and preparing industry skill standards.

- Develop and administer a national examination covering principles and applications of chemistry to certify chemical technicians after graduation. (See implementation plan.)

The National Perspective on Benchmarks and Standards

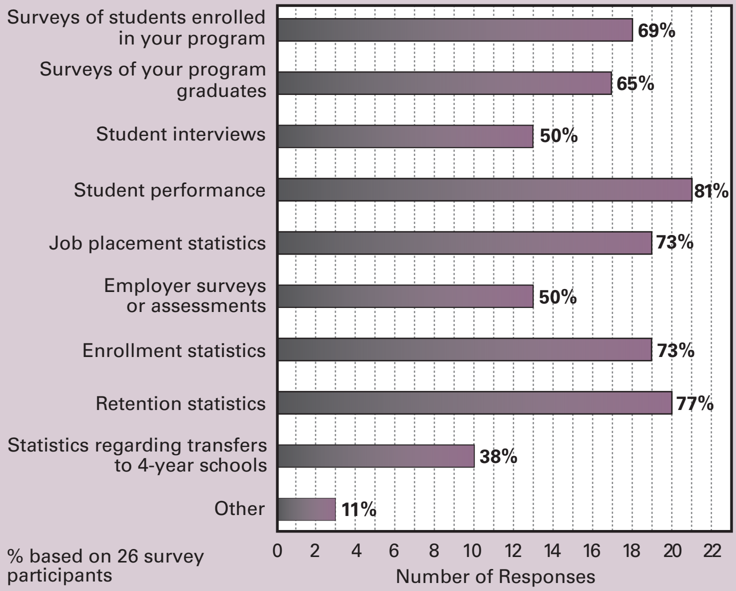
A regional accreditation associate or state certification agency formally approves most schools. Only 22% reported no approval for their programs.

Although only 37% of the programs had received ACS approval, which requires using the ACS ChemTechLinks Skill Standards, 66% of the programs cited them as the skill standards or performance indicators their programs had adopted. Half the programs followed local industry guidelines.

In terms of self-evaluation, programs used a wide variety of tools to asses their impact (please see Figure 3). Most focused on the students' accomplishments or opinions. Employer surveys or assessments were used by half of the survey respondents. ●

FIGURE 3

Percentage of chemistry-based laboratory technology programs using assessment tools to evaluate impact



% based on 26 survey participants

CRITICAL ISSUE 4
FACULTY RESOURCES

This critical issue encompasses the wide range of resources needed for faculty to fulfill their many responsibilities: teaching, administering programs, and developing alliances. Opportunities for interacting with industry hold particular importance for faculty in chemistry-based laboratory technology programs, even those with prior industry experience. Although faculty play essential roles, they often face limited time, financial resources, and incentives for their development.

Causative Factors

Community or technical colleges that offer chemistry-based laboratory technology programs usually have to cope with limited resources. At these institutions, faculty often carry excessive workloads that routinely exceed 30 contact hours per week. Administrations expect faculty to teach a full load as well as develop alliances, recruit students, and complete their own professional development activities.

Most institutions do not consider chemistry-based laboratory technology programs central to their mission and hence do not promote them well. Leveraging for resources within these institutions presents difficulties, given their minimal respect for and understanding of the chemical profession. As a result, most chemical technician training programs receive minimal monetary support relative to other academic departments.

Causative Factors: Limited Resources for Faculty

- Faculty workload often significantly exceeds 30 contact hours.
- Faculty are expected to teach a full load as well as develop alliances, recruit students, and update personal knowledge.
- Educational institutions do not promote the chemical technician career.
- The chemical technician profession and technical college degree often receive minimal respect.
- Just about everything relating to chemical technician training receives minimal monetary support.
- Faculty often lack industry experience or knowledge about how things work in industry.
- No sources offer training in practical applications.
- Curriculum developers make no distinction between chemical theory and industrial application.

Such institutions often fail to understand the need for industry-focused resources and interaction with industry. Lack of industry experience or knowledge about how things work in industry can limit their faculty's effectiveness in preparing students for the workplace. Few faculty receive industry-centered professional development opportunities or the incentives to pursue them. Furthermore, textbook developers offer science curricula that focus on chemical theory at the expense of industrial application.

Potential Effective Practices

The following strategies could be pursued to help address the factors limiting faculty resources.

To provide for faculty professional development and training resources:

- Encourage faculty to participate in summer institutes.
- Invite personnel from the National Science Foundation (NSF) and other curriculum development supporters to explain how to use the materials they have developed.
- Share effective practices at Two Year College Chemistry Consortium ($2YC_3$) conferences and other venues for faculty.

To provide for increased collaboration between industry and faculty:

- Encourage students to participate in externships and shadowing;
- Use industry personnel as adjunct faculty.
- Encourage faculty to participate where possible in industry functions such as seminars, workshops, tours, and social functions.
- Institute a faculty awards program analogous to the American Chemistry Council (formerly the Chemical Manufacturers Association) award program to build faculty recognition within the program, college, community, local ACS section, national ACS office, and industry.
- Publicize the new program's awards via local press releases.

To assist faculty:

- Provide grant proposal ideas and workshops.
- Provide information to college administrators that relates to faculty workload in chemical technician education.
- Provide information and resources for performing classroom duties and activities. (See implementation on opposite page.)

The National Perspective on Faculty Resources

Survey results provided more insights into causative factors raised at the conference. Conference participants

A Possible Implementation Plan for Providing Educational Resources and Information

Goals:

- Familiarize faculty with newly developed materials and their intended use.
- Update faculty about new developments in instrumentation.
- Hold workshops and symposia covering modern educational strategies and techniques.

Partners:

- ChemTechLinks
- Various NSF projects
- ACS local sections
- Industry partners

Possible Activities:

- Schedule C_3T, PACT, and ACT principal investigators or other representatives to travel to host campuses for one-on-one or group sessions to explain the materials that have been developed.
- Schedule industry partners or instrument manufacturers to travel to host campuses to present seminars for instrumental analysis of samples.
- Schedule sessions for faculty to visit industrial sites for demos and shadowing to learn how to use modern instrumentation.
- Schedule symposia at $2YC_3$ conferences to present modern educational strategies and techniques applicable to chemical technician education.
- Present certificates of recognition, participation, or both to participants.

Expenses:

- Transportation
- Hotel accommodations
- Meals
- Registration fees
- Lab supplies
- Stipends for faculty
- Honoraria for presenters

Sources of Income:*

- Site visitors can be reimbursed via ChemTechLinks, other NSF monies, or the host college.
- Industry partners and instrument manufacturers traveling to a host college may be able to pay their own expenses.
- Faculty expenses for industry visits and shadowing may not be significant (if the industry is local); otherwise, either the faculty member's college or the industry partner could pay expenses.
- College budgets normally cover expenses related to $2YC_3$ conferences.

Timeline:

- Allow two months' advance planning for site visits to a campus or industrial site. If funding is not needed, the time maybe shortened.
- If the visit involves travel, it may take a year or more to secure funding.
- Arrange symposia and speakers for $2YC_3$ conferences at least six months ahead.

Assessment:

- Develop assessment tools so all parties can evaluate the presenters and the general activities.
- Where appropriate, schedule a follow-up meeting to assess past activities and plan for those in the future.
- Consider whether to involve ChemTechLinks in assessment.

*The Moses Passer Fund, administered by the ACS Division of Chemical Education, is another source of support for selected faculty development activities.

cited the workload for full-time faculty as a concern; at times it exceeds 30 contact hours per week. In the survey, only 11% of the responding programs reported averages of more than 25 contact hours per week. With 7% of the respondents indicating an average of 21–25 hours and 41% in the 16–20 hour range, it is clear that faculty still have limited time for other activities. The survey did not determine the amount of time that faculty spent on additional responsibilities.

Most full-time faculty probably also face a significant time demand for administrative and advising tasks, given the fact that 17 of the responding programs had fewer than four full-time faculty to teach chemical laboratory technology courses. Four of these 17 programs had only 1 full-time faculty member, and 1 had none. In 8 of the programs responding to the survey, all of the full-time faculty teaching courses in the chemical technology program taught in it exclusively. The extent to which programs rely on part-time faculty varies. In 7 programs, no part-time faculty taught chemical laboratory technology courses.

Only 19% of the responding programs listed no financial support for professional development of full-time faculty, while 41% offered at least $500 per year. Part-time faculty enjoyed significantly less support, with two-thirds getting no support whatsoever.

Survey results seemed to confirm a lack of recent faculty involvement with industry. Some 63% of the programs included no faculty member who had gained industry-based experience within the past five years. Only 37% had more than one staff member with recent industrial experience. ●

CRITICAL ISSUE 5

INCORPORATING UPDATED TECHNOLOGY AND RELEVANT SUBJECT MATTER INTO CURRICULA

Given the rate that science and technology change, it is important for faculty in chemical technology programs to be aware of what is happening in the industry and modify their curricula appropriately. Conference participants noted that technology programs cannot realistically own the same equipment and instrumentation as industry, but they can prepare students to adapt both to it and to the new technologies to come. Acquiring reasonably up-to-date instrumentation and expertise that reflect industry needs constitutes the challenge.

Causative Factors

Lack of funding presents a critical barrier to incorporating updated technology and relevant subject matter into the curriculum. An information deficit about funding sources in industry and granting agencies aggravates the funding shortage.

Without a strong alliance, industry infuses only limited funds and equipment into a chemical technology program. A dedicated staff member whose role is to secure resources for critical technologies can increase funding success.

Causative Factors: Curricula Without Updated Technology and Relevant Subject Matter

- Lack of funding presents a critical barrier to updating curricula.
- An information deficit about funding sources in industry and granting agencies aggravates the funding shortage.
- Without a strong alliance, industry infuses only limited funds.
- Dedicated staff to secure funding for critical technologies are needed.
- Choosing core technology requirements is difficult, especially when a variety of equipment could be purchased. This requires assessing applicable local and national, present and future needs.
- A greater variety of technologies also creates the need for additional equipment maintenance, curriculum materials, training, etc., which may tax existing resources.
- The greater application of technology also increases the need for designing new experiments, which may lie outside the faculty's expertise.

Success at acquiring funds increases the variety of equipment that could be purchased. Deciding which equipment is most essential for meeting core technology requirements therefore demands assessing the current program with an eye on potential future needs or emerging technology.

A greater variety of technologies also creates the need for additional equipment maintenance, curriculum materials, training, etc., which may tax existing resources. The greater application of technology also increases the need to design new experiments, which may lie outside the faculty's expertise.

Potential EffectivePractices

The following strategies could be pursued to help address the causative factors for curricula without updated technology and relevant subject matter.

- Foster greater industry involvement in formulating curricula.
- Develop a model to facilitate a relationship between industry and academia that allows students and faculty to train at both industrial and other academic facilities. (See implementation plan on opposite page.)
- Encourage alliance's industry partners to send faculty for specialty training, engage in "internships," or both, thus fostering closer working relationships.
- Use skill standards surveys to prioritize and coordinate the acquisition of materials and equipment to meet curricular needs.
- Guide the local alliance in establishing relationships with equipment vendors.
- Share equipment needs and solicit industrial partners in alumni newsletters. Work with the alumni office to obtain contributions of both equipment and money.
- Establish and maintain instrumentation training plans.
- Develop or expand grant-writing support focused on partnerships and chemical technology education.
- Submit grant proposals to the National Science Foundation's program for Advanced Technological Education and apply for equipment grants.
- Share effective models across all programs by including them both in ChemTechLinks publications and on its website.

The National Perspective on Technology and Curricula

The survey seemed to portray sufficient, although not lavish, support for programs in terms of curriculum review and appropriate technology. Only 40% of respondents considered their equipment and instrumentation either completely or barely sufficient to support their program. At the same time, 52% regarded their equipment as mostly up-to-date by industry standards, with another 26% characterizing their equipment as moderately up-to-date. The programs possessed a wide range of types of instrumentation, presumably reflecting the variations in local industry needs.

The programs cited project grants and industry donations about as often as their institution's departmental and general program funds when asked about their source of support for obtaining technology. Yet only 19% of the programs had equipment budgets over $10,000 and 33% had budgets of only $500 or less. Only 15% of the programs had budgets over $5,000 for annual maintenance, with 30% working with budgets under $1,000.

Fifty-two percent of the programs responding indicated that they revise their curriculum every year, although the extent of the revisions is not known. ●

A Possible Implementation Plan for Creating Industrial Opportunities for Students and Faculty

Goals:
- Minimize barriers to sharing facilities.
- Develop professional and personal relationships among partners.
- Arrange access to facilities and instrumentation that the college does not possess.
- Expose students to current technology and practices.

Partners:
- College faculty
- Administrative and legal departments of college
- Students
- Equivalent personnel from other academic institutions
- Industrial partners at appropriate levels

Possible Activities:
- Locate appropriate partners and contacts.
- Initiate discussions of partners' roles and goals.
- Arrange to tour facilities and resources.
- Continue to discuss the partnership's desired relationship and goals.
- Invite administrators and corporate management to draft agreements concerning the partnership's interactions with other contracts and agreements.
- Engage in training and lab activities across facilities.

Expenses:
- Travel
- Meals
- Lab supplies
- Faculty stipends
- Internal costs–legal, office supplies, etc.

Sources of Income:
- Corporate sponsorship
- Internal grants
- External grants

Timeline:
- 2–4 days. Locate appropriate partners and contacts.
- 1–3 weeks. Arrange tour of facilities and resources.
- 2–3 weeks. Initiate discussion of partners' roles and goals.
- 2–4 weeks. Discuss partnership's desired relationship and goals.
- 1–3 months. Administrators and corporate management draft agreements concerning the partnership's interactions with other contracts and agreements.
- 1–3 months. Engage in training and lab activities across facilities.
- 1–5 months. Publish model based on input from all parties.

Assessment:
- Evaluate the planning process, model development, and its implementation.
- Gather evaluations from faculty, students, and partner personnel.

CRITICAL ISSUE 6

COMMUNITY AWARENESS OF THE CHEMICAL TECHNOLOGY PROFESSION

This critical issue relates to a program's ability to recruit students, engage community organizations in alliances, and obtain financial support. Despite the significant changes to the nature of work being done, many in the community still believe that chemical laboratory technicians simply follow directions. Somehow the chemical technology programs must convey the value of the professional contributions that laboratory technicians make, along with an appreciation of the job's problem-solving aspects.

Causative Factors

Unfavorable stereotypes of laboratory technicians have persisted, despite their changing and expanding role in industry; the problem is often compounded by a fear of chemistry. The general public remains unaware of the professional responsibilities and the good salaries that technicians can and do earn. Technicians are generally considered to have labor-based jobs rather than scientific careers. The public also perceives two-year degrees that many technicians have earned as being substandard to and less prestigious than four-year degrees.

The career's image suffers because poor marketing fails to convey the full scope and value of chemical technology during routine community discussions involving environmental issues, planning and zoning, taxes, and other vital topics. Industry engages in no, or at best limited, outreach to explain the chemical technician profession, resulting in an essentially "invisible" career.

Causative Factors: Limited Awareness of Chemical Technology Careers

- Unfavorable stereotypes of technicians and chemistry exist within industry, high schools, and four-year colleges, often accompanied by a fear of chemistry.
- The general community remains unaware of the profession and the good salaries that technicians can and do earn.
- The public perceives two-year degrees as being less prestigious than four-year degrees and considers technicians to have labor-based jobs rather than professional careers.
- Poor marketing fails to convey the full scope and value of chemical technology during routine community discussions involving environmental issues, planning and zoning, taxes, and other vital topics.
- Industry engages in no, or at best limited, outreach to explain the chemical technician profession, making it essentially an "invisible" career.

Possible Implementation Plan for Informing the Public about Chemical Technicians

Goals:
- Inform the public about chemical technicians' roles and the industries they serve.
- Develop effective ad copy that promotes the profession.
- Raise the profession's prestige.
- Publicize chemical technicians' positive contributions.
- Raise awareness of chemical technicians' positive impact on financial, social, educational, and other aspects of community life.
- Publicize the benefits of a chemical technician career.

Partners:
- Alliance members

Possible Activities:
- Place print, voice, and video ads at appropriate times and places.
  - Newspaper ads
  - Theater slides during previews
  - Local cable channels for airing ACS chemical technician videos
  - Radio ads
  - Feature articles for newspapers
  - Piggy-backing on community-college advertising
  - Posters and billboards

Expenses:
- Cost of paid ads
- Printing costs
- Billboard rental
- Mailing expenses

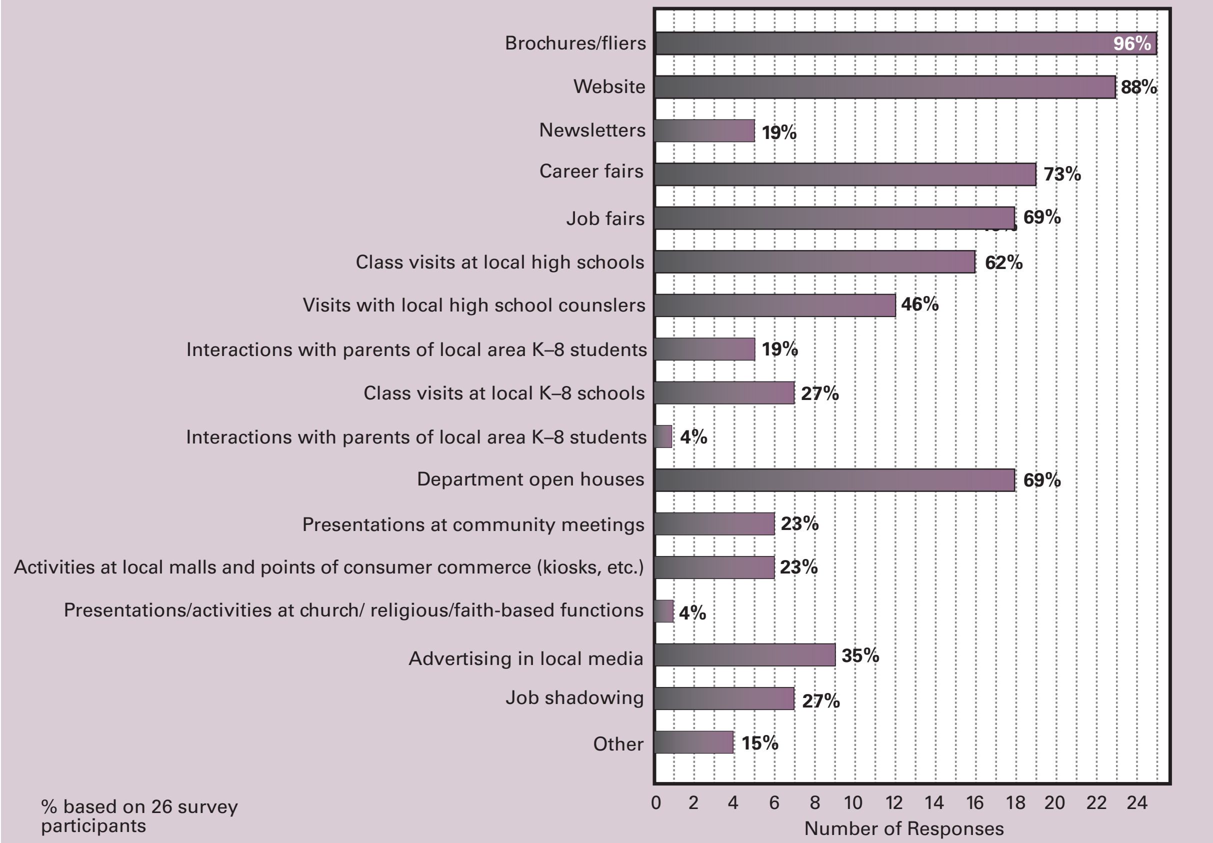
Sources of Income:
- Donations
- Fundraising campaign
- Alliance members
- Corporate sponsorship

Timeline:
- Run ads in October, March, and August—just prior to two-year college enrollment periods.

Assessment:
- Track the number and placement of ads or notices.
- Conduct surveys to assess community awareness of ads.

FIGURE 4

Percentage of chemistry-based laboratory technology programs involved in outreach activities



Potential Effective Practices

The following strategies could be used to help address the factors limiting awareness of chemical technology careers.

- Use ACS local sections and industry alliance partners to sponsor and develop outreach activities.
- Publicize awards.
- Carefully design outreach programs for targeted audiences.
- Present programs to parent-teacher associations and other parent groups.
- Make presentations in community college orientation classes.
- Design an alliance-sponsored billboard ad.
- Place ACS video “Opening Doors of Opportunity” on a local cable channel.
- Develop an alliance-sponsored ad campaign to show during movie theater previews.
- Place web links for chemical technicians on workforce websites.
- Sponsor or participate in job fairs through alliances.
- Encourage students to enter science fairs by advising them about projects.
- Sponsor service projects, such as soil testing, to garner media attention.
- Work with Boys & Girls Clubs, Scouts, and other groups whose activities engage young people.
- Participate in community events with parade floats, booths, etc.
- Participate in National Chemistry Week.
- Publicize activities in the media.

The National Perspective on Community Awareness Activities

The survey responses reflect many of the effective practices suggested at the conference (please see Figure 4). Essentially all of the programs used brochures or fliers and 93% used a website for outreach. At least two-thirds of the programs participated in career fairs, job fairs, and departmental open houses, and nearly the same number visited high school classes. Slightly fewer than half of the programs visited high school counselors. Of the respondents, 48% used Student Affiliates as a resource for outreach and 44% used National Chemistry Week. ChemTechLinks was used by 41% of the programs.

CRITICAL ISSUE 7
EMPLOYABILITY SKILLS

Given the extent to which chemical technicians interact with others, they must possess good communication skills and the ability to work in teams. As with other higher education programs, those for chemistry-based laboratory technology face challenges in finding ways to prepare students for all aspects of their careers. In addition to mastering skills and knowledge relating to science and technology, graduates of technology education also need employability skills covering such areas as communication, problem-solving, positive attitudes and behaviors, adaptability, and the ability to work in a culturally diverse setting.

Causative Factors

Because certificate and two-year programs focus on science content, they do not emphasize communication skills such as writing lab notebooks, documenting data, technical writing, verbal and listening skills, writing reports, and communicating data and conclusions orally. Including such activities can prove particularly challenging in light of the wide range of student backgrounds. In many cases faculty may not possess the qualifications or time to develop assessments geared to improving communication skills. Efforts to do so can be counteracted by the differences between college and workplace cultures regarding attendance, work habits, group responsibilities, and evaluations. Without opportunities for work experiences, job shadowing, co-ops, or internships—as well as mentors who understand the

Causative Factors: Lack of Employability Skills

- Chemical technician curricula do not emphasize communication skills such as writing lab notebooks, documenting data, technical writing, verbal and listening skills, writing reports, and communicating data and conclusions orally.
- The backgrounds of incoming students vary widely.
- Faculty may not possess the qualifications or time to develop assessments geared to improving communication skills.
- Colleges and workplaces may hold very different expectations regarding attendance, work habits, group responsibilities, and evaluations.
- Students may lack opportunities for work experiences, job shadowing, co-ops, or internships.
- People in the profession often do not understand the importance of communication skills.

A Possible Implementation Plan Addressing Employability Skills

Goals:
- Inform students of workplace expectations.
- Offer role models.
- Demonstrate by example.

Partners:
- ChemTechLinks
- Alaska Process Industry Careers Consortium
- Chemistry-based technology programs
- Industry representatives
- Program alumni

Possible Activity:
- Publish a list, brochure, or poster setting forth expected professional behaviors and attitudes.

Expenses:
- Design
- Printing
- Distribution

Sources of Income:
- Industry contributions
- Sponsors
- Grants

Timeline:
- Obtain a copy of Alaska Process Industry Careers Consortium model.
- Use industry partners to validate content and add any missing elements.
- Prepare draft electronically.
- Include examples of acceptable, questionable, and unacceptable behaviors.
- Circulate draft and post for comments and feedback.
- Solicit financial support from industry sponsors.
- Distribute revised draft for comments.
- Finalize content.
- Submit draft for editing, design, and proofreading.
- Print and distribute materials, also posting them on the ChemTechLinks website.
- Publicize online via e-mail, links to partner sites, listserv, and the ChemTechLinks website.

Assessment:
- Track requests for poster, brochure, or other materials and downloads.

importance of developing good communication skills—students may not come to understand workplace expectations.

Potential Effective Practices

The following strategies could be used to help address the causative factors of poor employability skills.

To improve overall employability skills:

- Include resume writing, interviewing, and general employability skills in the curriculum, and include participation and attendance in the course grade. Emphasize these skills' real-world applicability to students.
- Include an element of peer review experience in student coursework.
- Establish a formal work-ethics program that explains expectations to students and that actually includes a work-ethics grade as part of the academic grade.
- Require students to develop electronic portfolios that include resumes and other documents. (For an example, see careercruising.com.)
- Invite industry speakers to discuss the importance of soft skills with students.
- Require students to attend career- and workplace-skills workshops wherever available, if the formal curriculum does not otherwise include them.
- Communicate expected workplace behavior to students via posters, brochures, and other means.
- Include internships or other workplace experiences in the curriculum.
- Emphasize truthfulness on employment applications.
- Develop workplace experiences for faculty and staff so they gain a better understanding of workplace expectations.

To improve communication skills:

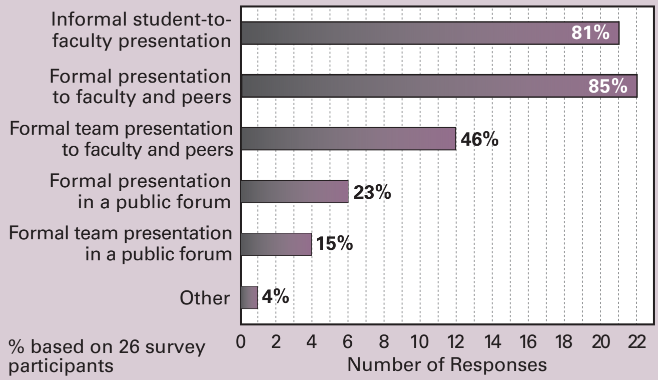
- Provide time, training, and resources for faculty to evaluate written documents and oral presentations.
- Take advantage of students' differences to help them learn to communicate effectively, appreciate differences, and work well in groups.
- Emphasize communication skills by requiring more written, oral, and presentation work in class.
- Require students to generate individual or group reports about laboratory experiments and present their conclusions orally to the class as part of their graded assignments.
- Design capstone projects to include oral presentations in front of advisory board members, industry representatives, or both.
- Incorporate the Secretary's Commission on Achieving Necessary Skills (SCANS) report, What Work Requires of Schools. This 61-page report defines the five competencies and three-part foundation that constitute the skills young people need to succeed in the world of work.

To develop leadership skills:

- Rotate students as team leaders in course assignments.

FIGURE 5

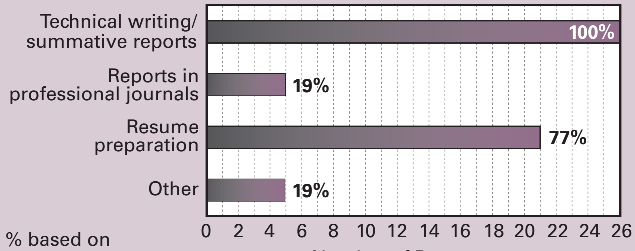
Percentage of chemistry-based laboratory technology programs integrating oral communication skills into the curriculum



% based on 26 survey participants

FIGURE 6

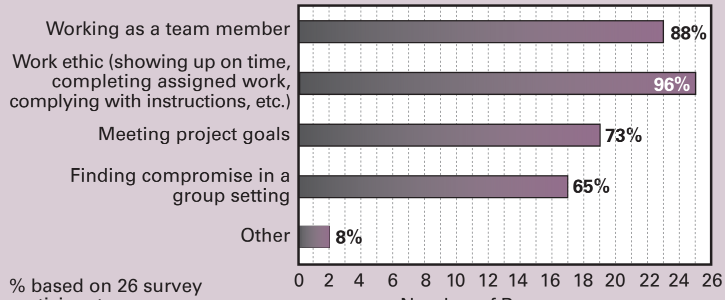
Percentage of chemistry-based laboratory technology programs integrating written communication skills into the curriculum



% based on 26 survey participants

FIGURE 7

Percentage of chemistry-based laboratory technology programs integrating workplace skills, behavior, or both into the curriculum



% based on 26 survey participants

The National Perspective on Employability Skills

Chemistry-based chemical technology programs are incorporating curricular elements that address the need for oral and written communication skills and workplace behaviors (see Figures 5–7). Although the survey did not shed light on how frequently various programs incorporate employability skills training or the intensity of these activities, it did provide insight into the breadth of activities schools are using to help with these so called "soft skills". ●

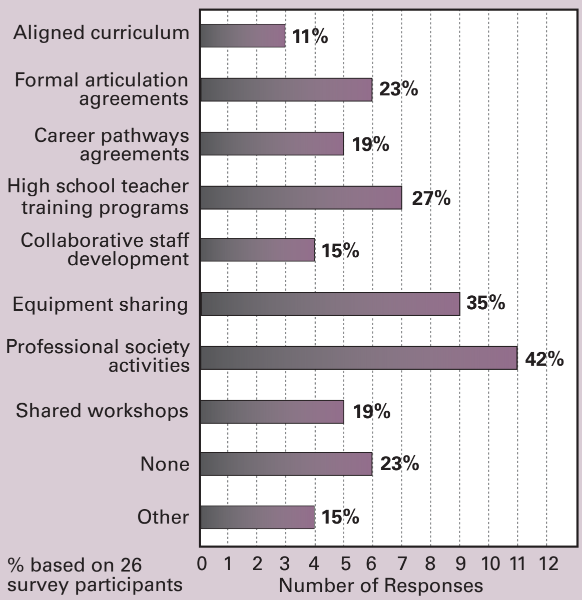
CRITICAL ISSUE 8

RELATIONSHIPS TO GRADES K–16

A seamless, or integrated, educational system can help provide adequately prepared students and introduce them to available career options. Although the conference participants did not discuss this critical issue in great detail, the survey asked several related questions.

FIGURE 8

Percentage of chemistry-based laboratory technology programs collaborating with high schools

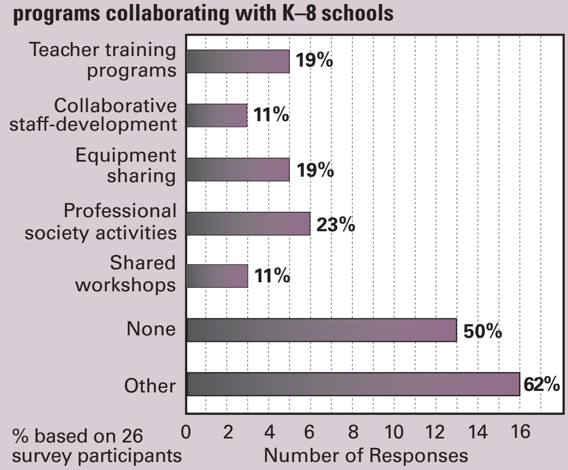


The National Perspective on Relationships to Grades K–16

A limited number of programs are participating in a wide range of activities in conjunction with secondary and elementary schools (see Figures 8–9). Forty-six percent of the survey respondents collaborated with high schools on professional society activities, showing that to be the most popular activity associated with this critical issue. This response highlights the role that third parties can play in fostering interactions. Less than a third of the respondents conducted all of the other activities with K–8 and high schools. ●

FIGURE 9

Percentage of chemistry-based laboratory technology programs collaborating with K–8 schools



CRITICAL ISSUE 9

INDUSTRIAL EXPERIENTIAL LEARNING OPPORTUNITIES

As noted earlier, industrial experiences can increase the number of students retained and help them develop the entire range of skills they need to succeed in the workplace. Although the conference did not discuss this critical issue directly, conversations about experiential learning opportunities indicated the importance of partnering with industry and placement agencies.

The National Perspective on Internships

Internships constituted part of the degree requirements for 59% of the programs responding. The number of required hours varied, with 25% of the programs not specifying any. Of the programs setting requirements, 25% required fewer than 200 hours and 25% required 300 hours or more.

A great deal of effort goes into finding internships. Of the programs responding, 19% used the help of a placement office, while 56% received assistance from the program chair or faculty. In 26% of the programs, students found internships on their own. Agreements with local industry resulted in internships in only 22% of the programs, despite the fact that a higher number have alliances with industry partners. In terms of payment, 15% of the programs placed students only in paid internships and 19% only in unpaid internships. ●

SUMMARY

Preparing students for the world of work is a challenging endeavor. The ChemTechLinks Conference 2004 and the subsequent survey of chemistry-based laboratory technology programs in 2005 have provided additional insights into how programs, industry, and other organizations can better meet these challenges. The conference participants discussed what they believe to be the most pressing problems in their chemistry-based technology programs. They also looked carefully at what they perceive as the important underlying factors contributing to these critical issues.

Conference participants discussed ways to overcome or minimize the effects of these causative factors and offered suggestions for effective practices, along with draft implementation plans for some. Results from the survey of programs provide more insight into the current state of programs and highlight opportunities for improvement. Combined, these items provide a powerful way to support and help technology programs. Together we can strengthen our chemical technology programs and provide the chemical process industry with the well-educated individuals it needs for the chemistry-based technician profession. ●

Several of the suggestions made in this report refer to ChemTechLinks and the services it provides. More information can be found at www.chemtechlinks.org.

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APPENDIX I

ChemTechLinks Conference 2004 Participant List

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APPENDIX II
ChemTechLinks Conference 2004 Schedule

ChemTechLinks

Critical Issues and Effective Practices in
Chemistry-Based Laboratory
Technology Education
July 16–18, 2004

Friday, July 16, 2004

4:00–7:00 PM . . . . .Registration.
6:00–7:00 PM . . . . .Social Hour.
7:00–9:00 PM . . . . .Dinner.
Plenary Speaker: Dr. William F. Carroll, Jr., President-Elect, ACS
Title: "Opportunity: Does It Have a Future?"

Saturday, July 17, 2004

8:30–8:45 AM . . . . .Introductory Remarks.
8:45–10:00 AM . . . . .Identifying Critical Issues Session. (Assisted by CoVision)
What's Missing?
Discussion of Critical Issues.
10:00–10:15 AM . . . . .Intermission.
10:15–11:45 AM . . . . .Identifying Causative Factors Session. (Assisted by CoVision)
Team Presentations on Causative Factors.
11:45–1:15 PM . . . . .Lunch.
1:15–2:15 PM . . . . .Identifying Effective Practices Session. (Assisted by CoVision)
2:15–2:30 PM . . . . .Intermission.
2:30–3:30 PM . . . . .Identifying Effective Practices Session. (Continued)
Team Presentations on Effective Practices.
3:30–3:45 PM . . . . .Review of the Day's Outcomes.
3:45–5:00 PM . . . . .Overview of ChemTechLinks and Clearinghouse Focus Group.
6:00–7:00 PM . . . . .Social Hour.
7:00 PM . . . . .Dinner.

Sunday, July 18, 2004

8:30–8:45 AM . . . . .Review and Summary of Critical Issues and Effective Practices.
8:45–9:45 AM . . . . .Developing Model Implementation Plans for Effective Practices.
9:45–10:30 AM . . . . .Presentation of Implementation Plans.
10:30–10:45 AM . . . . .Intermission.
11:15–11:30 AM . . . . .Conference Evaluation.
11:30 AM . . . . .Conference Adjournment.
11:30 AM . . . . .Lunch.
12:00 NOON–1:30 PM . . . .Skill Standards Database Workshop and Focus Group.

APPENDIX III

CHEMTECHLINKS CONFERENCE 2004 PARTICIPANT SURVEY

Evaluation Summary

Introduction

The ChemTechLinks project of the American Chemical Society is supported by an Advanced Technological Education grant from the National Science Foundation. The ChemTechLinks Conference 2004: Critical Issues and Effective Practices in Chemistry-Based Laboratory Technology Education took place July 16–18, 2004 in Ames, IA. Twenty-seven leaders from industry, education, and government participated in the conference, which occurred immediately prior to the ACS Biennial Conference on Chemical Education.

Representatives from industry and academia were invited to attend the conference, where interactive technology and focus groups were used to

- identify critical issues facing laboratory technology education,
- explore factors influencing these issues,
- discuss effective practices for addressing these factors, and
- develop potential models for implementing selected practices.

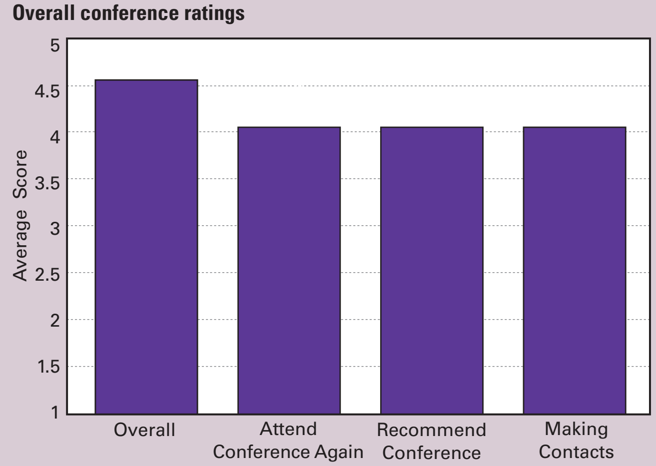
ChemTechLinks supports the ongoing development of a highly skilled, educated, and diverse technician workforce in the American chemical process industry. As a part of its mission, ChemTechLinks sponsored the conference to discuss the critical issues facing chemistry-based laboratory technology education, along with their causative factors and effective practices, and to identify future activities.

Winterton Associates, the external evaluator, worked with the ChemTechLinks staff to develop an instrument to obtain feedback from the conference participants concerning the conference. They used the CoVision system to obtain the evaluation data.

All conference participants were asked to fill out the conference evaluation prior to leaving the conference. Twenty-four participants completed the conference evaluation.

FIGURE 10

Overall conference ratings



Evaluation

Based on the overall feedback, the participants felt that the ChemTechLinks Conference 2004 was very successful. Twenty-two of the 24 respondents (92%) were satisfied or very satisfied with the conference overall. One participant stated, "Thanks! I liked the work in this conference; it provided me many useful and practical ideas! I liked the diversity of backgrounds and perspectives in our table groups. Good work planning this." Another respondent indicated a feeling that the conference was better than others the person had attended, "Overall excellent working conference—was able to participate rather than just watching others pat themselves on the back, as so often seems to happen at conferences." Eighteen of the 24 respondents (75%) strongly agreed that they would like to attend another ChemTechLinks Conference. Nineteen of the 24 participants (79%) agreed or strongly agreed that they would recommend attending the ChemTechLinks Conference to their colleagues.

A major goal of the conference was to aid participants in education and industry in making contacts. Eighteen of the 24 respondents (75%) agreed or strongly agreed that the conference aided them in making contacts. Among their comments, one participant specifically noted that the conference was a "good opportunity to develop new contacts!"

Figure 10 shows the average score given to questions about the overall success of the conference, with one being very satisfied and five being very dissatisfied.

Time Allotted for Sessions

Participants were asked to rate on a scale of 1–5 (one being very dissatisfied and 5 being very satisfied) how satisfied they were with the time they were allotted in the four sessions of the conference. The sessions they rated and the average score were:

- Identifying Critical Issues—average score = 4.0
- Identifying Causative Factors—average score = 3.9
- Identifying Effective Practices—average score = 4.0
- Developing Implementation Plans—average score = 3.8

Figure 11 shows how often each score was given. The graph indicates that a high percentage of the respondents were satisfied with the time allotted for each of the sessions. The total average score for all four sessions was 3.9 on a 5.0 scale. Although the average scores are positive, they are the lowest of all the sections in the evaluation. Several of the respondents noted that the schedule was ambitious and more time may have been helpful. Comments with regard to the allotted time included:

- "Only flaw was too short a time at the beginning to get the feel for the tasks ahead and to learn how to use the technology."
- "This conference had a very ambitious agenda and there was not enough time allowed for some of the topics."
- "Rather rushed in discussing very important issues."
- "Rather rushed in such important matters."

Overall the participants agreed that the issues and topics discussed were very important and warrant additional opportunities for discussion.

Usefulness of Resulting Information

Participants were asked to rate on a scale of 1–5 (one being very dissatisfied and 5 being very satisfied) how satisfied they were with the usefulness of the information resulting from the four sessions of the conference. The sessions they rated and the average score were:

- Identifying Critical Issues—average score = 4.3
- Identifying Causative Factors—average score = 4.2
- Identifying Effective Practices—average score = 4.2
- Developing Implementation Plans—average score = 4.1

Figure 12 shows how often each score was given. The data from the conference participants indicate that most of them were satisfied or very satisfied with the usefulness of the information gathered in the four sessions shown in Figure 12. Eighty-three percent of the respondents gave a score of 4 or 5, with a total average of 4.2 for the four sessions. Several participants commented on the information developed at the conference:

- "Thanks! I liked the work in this conference—it provided me many useful and practical ideas! I liked the diversity of backgrounds and perspectives in our table groups; good work planning this."
- "I hope that there will be follow-up work on all of the great ideas that the participants came up with."
- "I would hope that data obtained by past ChemTech forums, especially those sponsored by PACT, will also be utilized in making any conclusions or recommendations. It seems that the wheel may be in the process of being reinvented."

FIGURE 11

Satisfaction with allotted time

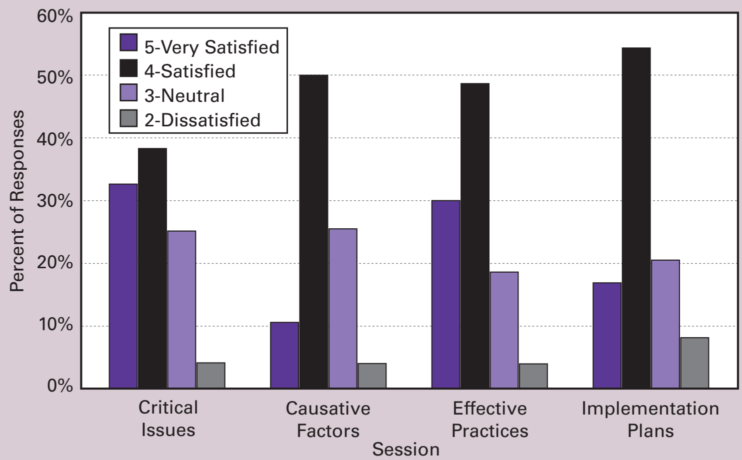
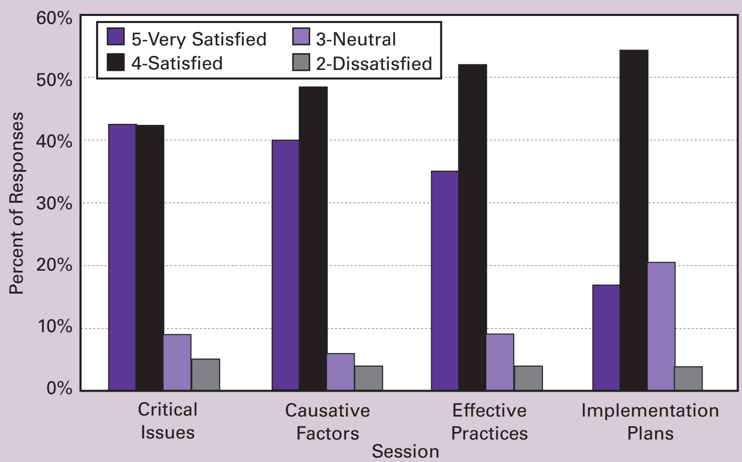


FIGURE 12

Usefulness of resulting information



Session Processes

Participants were asked to rate on a scale of 1–5 (one being very dissatisfied and 5 being very satisfied) how satisfied they were with the processes used to develop the information during the four sessions of the conference. The sessions they rated and the average score were:

- Identifying Critical Issues—average score = 4.2
- Identifying Causative Factors—average score = 4.3
- Identifying Effective Practices—average score = 4.3
- Developing Implementation Plans—average score = 4.1

FIGURE 13

Session processes

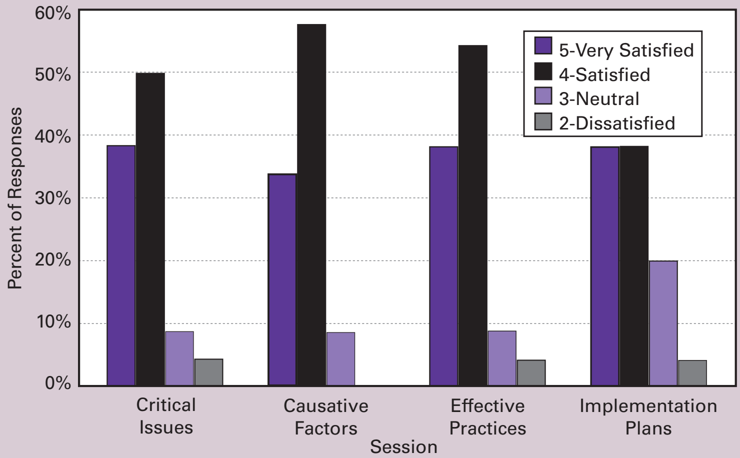


Figure 13 shows how often each score was given. Based on the data collected, the conference participants were satisfied with the processes used to develop the information at each of the sessions. For the four sessions in Figure 13, an average of 82% of the respondents rated the session processes a 4 or 5. One of the participants provided insight regarding the implementation plan score: "There was not enough time allowed for some of the topics—especially for development of the implementation plans. I hope that there will be follow-up work on all of the great ideas that the participants came up with."

When asked to rate the ease of use of the CoVision technology, respondents were also very positive. Twenty-one of the 24 respondents (86%) rated the ease of use of CoVision as a 4 or 5. When asked how effective the CoVision system was, all but 3 of the participants (87%) gave a rating of 5, very satisfied.

Recommendations

1. Continue using the CoVision technology for appropriate conferences conducted by ChemTechLinks. Participants viewed the CoVision technology as a helpful method of gathering information from the group as a whole. Continued use of the CoVision system will allow the ChemTechLinks organization to effectively tap the knowledge and experience of future conference participants.
2. Follow-up should be conducted on the implementation plans and the successes or challenges shared with the conference participants.
3. In future conferences, a more limited agenda or additional time should be considered in order to allow more detailed discussion and input from participants.
4. Disseminate the results of the ChemTechLinks conference to a broader audience that might benefit from the process and findings.
5. Review the additional comments from the Conference Evaluation and determine which ones can or cannot be addressed and why.

ChemTechLinks Conference Evaluation Data

1. Overall Conference
(Participants voted on a scale of 1 to 5,
Very Dissatisfied to Very Satisfied)
Average: 4.6 Standard Deviation: 0.6
Total Votes: 24

Scale	Votes	Percentage
5	17	71%
4	5	21%
3	2	8%
2	0	0%
1	0	0%

2. On-Site Registration/Check-In
(Participants voted on a scale of 1 to 5,
Very Dissatisfied to Very Satisfied)
Average: 4.8 Standard Deviation: 0.5
Total Votes: 24

Scale	Votes	Percentage
5	20	83%
4	3	13%
3	1	4%
2	0	0%
1	0	0%

3. Relevance to Your Job
(Participants voted on a scale of 1 to 5,
Very Dissatisfied to Very Satisfied)
Average: 4.3 Standard Deviation: 0.8
Total Votes: 24

Scale	Votes	Percentage
5	13	54%
4	5	21%
3	6	25%
2	0	0%
1	0	0%

4. Facilitator's Skills
(Participants voted on a scale of 1 to 5,
Very Dissatisfied to Very Satisfied)
Average: 4.6 Standard Deviation: 0.6
Total Votes: 24

Scale	Votes	Percentage
5	17	71%
4	5	21%
3	2	8%
2	0	0%
1	0	0%

5. Hotel Facilities
(Participants voted on a scale of 1 to 5, Very Dissatisfied to Very Satisfied)
Average: 4.5 Standard Deviation: 0.6
Total Votes: 24

Scale	Votes	Percentage
5	14	58%
4	8	33%
3	2	8%
2	0	0%
1	0	0%

6. Food/Refreshments
(Participants voted on a scale of 1 to 5, Very Dissatisfied to Very Satisfied)
Average: 4.3 Standard Deviation: 0.8
Total Votes: 24

Scale	Votes	Percentage
5	12	50%
4	7	29%
3	5	21%
2	0	0%
1	0	0%

7. Scheduling the conference in conjunction with the BCCE
(Participants voted on a scale of 1 to 5, Very Dissatisfied to Very Satisfied)
Average: 4.1 Standard Deviation: 0.8
Total Votes: 22

Scale	Votes	Percentage
5	9	41%
4	7	32%
3	6	27%
2	0	0%
1	0	0%

Time Allotted for Sessions

8. Identifying Critical Issues
(Participants voted on a scale of 1 to 5, Very Dissatisfied to Very Satisfied)
Average: 4 Standard Deviation: 0.9
Total Votes: 24

Scale	Votes	Percentage
5	8	33%
4	9	38%
3	6	25%
2	1	4%
1	0	0%

9. Identifying Causative Factors
(Participants voted on a scale of 1 to 5, Very Dissatisfied to Very Satisfied)
Average: 3.9 Standard Deviation: 0.8
Total Votes: 24

Scale	Votes	Percentage
5	5	21%
4	12	50%
3	6	25%
2	1	4%
1	0	0%

10. Identifying Effective Practices
(Participants voted on a scale of 1 to 5, Very Dissatisfied to Very Satisfied)
Average: 4 Standard Deviation: 0.8
Total Votes: 23

Scale	Votes	Percentage
5	7	30%
4	11	48%
3	4	18%
2	1	4%
1	0	0%

11. Developing Implementation Plans
(Participants voted on a scale of 1 to 5, Very Dissatisfied to Very Satisfied)
Average: 3.8 Standard Deviation: 0.8
Total Votes: 24

Scale	Votes	Percentage
5	4	17%
4	13	54%
3	5	21%
2	2	8%
1	0	0%

Usefulness of Resulting Information

12. Identifying Critical Issues
(Participants voted on a scale of 1 to 5, Very Dissatisfied to Very Satisfied)
Average: 4.3 Standard Deviation: 0.8
Total Votes: 23

Scale	Votes	Percentage
5	10	43%
4	10	43%
3	2	9%
2	1	5%
1	0	0%

13. Identifying Causative Factors
(Participants voted on a scale of 1 to 5, Very Dissatisfied to Very Satisfied)
Average: 4.2 Standard Deviation: 0.8
Total Votes: 23

Scale	Votes	Percentage
5	9	40%
4	11	48%
3	2	8%
2	1	4%
1	0	0%

14. Identifying Effective Practices
(Participants voted on a scale of 1 to 5, Very Dissatisfied to Very Satisfied)
Average: 4.2 Standard Deviation: 0.8
Total Votes: 23

Scale	Votes	Percentage
5	8	35%
4	12	52%
3	2	9%
2	1	4%
1	0	0%

15. Developing Implementation Plans
(Participants voted on a scale of 1 to 5, Very Dissatisfied to Very Satisfied)
Average: 4.1 Standard Deviation: 0.9
Total Votes: 23

Scale	Votes	Percentage
5	9	39%
4	8	35%
3	5	22%
2	1	4%
1	0	0%

Session Processes

16. Identifying Critical Issues
(Participants voted on a scale of 1 to 5, Very Dissatisfied to Very Satisfied)
Average: 4.2 Standard Deviation: 0.8
Total Votes: 24

Scale	Votes	Percentage
5	9	38%
4	12	50%
3	2	8%
2	1	4%
1	0	0%

17. Identifying Causative Factors
(Participants voted on a scale of 1 to 5, Very Dissatisfied to Very Satisfied)
Average: 4.3 Standard Deviation: 0.6
Total Votes: 24

Scale	Votes	Percentage
5	8	34%
4	14	58%
3	2	8%
2	0	0%
1	0	0%

18. Identifying Effective Practices
(Participants voted on a scale of 1 to 5, Very Dissatisfied to Very Satisfied)
Average: 4.3 Standard Deviation: 0.6
Total Votes: 24

Scale	Votes	Percentage
5	9	38%
4	13	54%
3	2	8%
2	0	0%
1	0	0%

19. Developing Implementation Plans
(Participants voted on a scale of 1 to 5, Very Dissatisfied to Very Satisfied)
Average: 4.1 Standard Deviation: 0.9
Total Votes: 24

Scale	Votes	Percentage
5	9	38%
4	9	38%
3	5	20%
2	1	4%
1	0	0%

CoVision Technology

20. Ease of Use of CoVision
(Participants voted on a scale of 1 to 5, Very Dissatisfied to Very Satisfied)
Average: 4.5 Standard Deviation: 0.8
Total Votes: 24

Scale	Votes	Percentage
5	16	67%
4	5	21%
3	2	8%
2	1	4%
1	0	0%

21. Effectiveness of CoVision
(Participants voted on a scale of 1 to 5,
Very Dissatisfied to Very Satisfied)
Average: 4.8 Standard Deviation: 0.6
Total Votes: 24

Scale	Votes	Percentage
5	21	88%
4	2	8%
3	0	0%
2	1	4%
1	0	0%

Overall

22. The conference aided me in making contacts
(Participants voted on a scale of 1 to 5,
Strongly Agree to Strongly Disagree)
Average: 1.8 Standard Deviation: 1.4
Total Votes: 24

Scale	Votes	Percentage
5	3	13%
4	1	4%
3	2	8%
2	1	4%
1	17	71%

23. I would attend another ChemTechLinks conference
(Participants voted on a scale of 1 to 5,
Strongly Agree to Strongly Disagree)
Average: 1.8 Standard Deviation: 1.4
Total Votes: 24

Scale	Votes	Percentage
5	3	12.5%
4	0	0%
3	3	12.5%
2	0	0%
1	18	75%

24. I would recommend to colleagues that they attend this conference.
(Participants voted on a scale of 1 to 5,
Strongly Agree to Strongly Disagree)
Average: 1.8 Standard Deviation: 1.4
Total Votes: 24

Scale	Votes	Percentage
5	3	12.5%
4	1	4%
3	1	4%
2	3	12.5%
1	16	67%

25. Please offer any comments or suggestions. (Participants entered the following comments)

001 Only flaw was too short a time at the beginning to get the feel for the tasks ahead and to learn how to use the technology.

002 Have soft drinks available at social hour.

003 Great job!

004 CoVision is not a program that many are familiar with. It would have been easier to use a common word-processing software, e.g., Word or Word Perfect, with spell check, cut and paste capabilities.

005 Add a click on pad feature and a second mouse button to the computers.

006 This conference had a very ambitious agenda and there was not enough time allowed for some of the topics—especially for development of the implementation plans. I hope that there will be follow-up work on all of the great ideas that the participants came up with.

007 Thanks! I liked the work in this conference—it provided me many useful and practical ideas! I liked the diversity of backgrounds and perspectives in our table groups—good work planning this.
Good opportunity to develop new contacts!

008 Overall excellent working conference—was able to participate rather than just watching others pat themselves on the back as so often seems to happen at conferences. Could have improved definition of task when defining causative factors and I think critical issues was perhaps a misnomer in the context in which it was used in this conference. To me, a critical issue is something that's of great importance rather than necessarily something with which a problem exists. Had we defined critical problems instead of critical issues, this would have made intent more obvious and wording would have been consistent with meaning and would have been easier to identify causative factors.

009 Rather rushed in such important matters. Would like to have a copy of the potential implementation plans.

010 Everything was excellent.

011 Please add high school programs to ChemTech program directory. (ie., the Milby High School program in Houston.)

012 Computers should be provided with track mice.

013 I would hope that data obtained by past ChemTech forums, especially those sponsored by PACT, will also be utilized in making any conclusions or recommendations. It seems that the wheel may be in the process of being reinvented with many topics discussed.

APPENDIX IV
MODEL IMPLEMENTATION PLAN

Critical Issue: Recruitment

Causative Factor(s): Student lack of familiarity with career options; Misperceptions about careers in the chemical industry

Effective Practice: ChemTech Summer Camp (based on Recruitment Camp held at University of Toledo)

Overview of Effective Practice:

High school students are invited to spend 3–5 days attending a summer camp. Camp activities include tours of the campus and local industry, career seminars, and lab activities. The schedule allows parents to attend a number of events.

Goals:

- To inform students and their families about opportunities in chemistry-based technology
- To expose students to the types of activities and expectations that are part of college in general and of chemistry-based technology programs in particular
- To interest students in enrolling at the host institution and seeking employment at the participating local industries

Partners:

- Chemistry-based technology program
- Admissions office
- Local high school faculty
- Industry representatives
- Current and former students
- ACS Student Affiliates Chapter

Possible activities:

- Opening reception*
- Tour of industry*
- Presentation about chemistry-based technology careers (panel discussion)*
- Tour of campus*
- Laboratory activities (*Science in a Technical World* modules)
- Career planning workshops
- Closing picnic*

* Involving the families of camp participants will help build an informed and supportive home environment.

Expenses:

- Accommodations (if camp participants stay overnight)
- Meals, refreshments, or both
- Lab supplies
- Faculty stipends

Sources of Income:

- Corporate sponsorships
- Student registration fees (good to have, but keep low)
- Campus funds
- ACS Student Affiliates Chapter grants (Innovative Activities or Community Interaction–Student Affiliates grants)*

*To apply, the chapter must be active, have six Student Affiliates whose dues have been paid, and have submitted an annual report in the last three years.

Timeline:

Summer preceding the camp:

- Meet with partners, discuss overall plans, set detailed planning timeline

Fall preceding the camp:

- Solicit funds
- Design application process
- Develop schedule of camp activities

Winter preceding the camp:

- Determine registration fee
- Send applications
- Visit classrooms
- Distribute promotional materials at community centers

Spring preceding the camp:

- Review applications
- Send acceptance packets
- Handle event logistics

Summer:

- Hold camp

Fall following the camp:

- Maintain contact with campers

Spring or summer following the camp:

- Track number of campers enrolling in program

Assessment:

- Evaluation of planning process
- Evaluation of camp (by campers and others involved)
- Tracking of outcomes (campers enrolling in program)