AN ABSTRACT OF THE DISSERTATION OF

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Two-year chemistry-based technology training (CBTT) programs in the U.S. are important in the preparation of the professional technical workforce. The purpose of this study was to identify, examine, and analyze factors related to the economic sustainability of CBTT programs. A review of literature identified four clustered categories of 31 sub-factors related to program sustainability. Three research questions relating to program sustainability were: (1) What is the relative importance of the identified factors?, (2) What differences exist between the opinions of administrators and faculty?, and (3) What are the interrelationships among the factors? In order to answer these questions, survey data gathered from CBTT programs throughout the United States were analyzed statistically. Conclusions included the following:

- Rank order of the importance to sustainability of the clustered categories was: (1) Partnerships, (2) Employer and Student Educational Goals, (3) Faculty and Their Resources, and (4) Community Perceptions and Marketing Strategies.
- Significant correlations between ratings of sustainability and the sub-factors included: degree of partnering, college responsiveness, administration involvement in partnerships, experiential learning opportunities, employer input in curriculum development, use of skill standards, number of program graduates, student job placement, professional development opportunities, administrator support, presence of a champion, flexible scheduling, program visibility, perception of chemical technicians, marketing plans, and promotion to secondary students.
- Faculty and administrators differed significantly on only two sub-factor ratings: employer assisted curriculum development, and faculty workloads.
- Significant differences in ratings by small program faculty and administrators and large program faculty and administrators were indicated, with most between small program faculty and large program administrators.

The study concluded with suggestions for educators, employers, professional organizations, and legislators. These suggestions included: Educators should work collaboratively in partnerships to encourage employer input, internships, and job placement of graduates. Programs should be supported by administrators and continued outside resources. Professional development opportunities should be afforded to faculty, along with reasonable workloads. Programs need high community visibility and should be promoted to secondary students. Finally, program size should be considered when adopting strategies for CBTT program sustainability.

Factors Related to the Economic Sustainability of Two-Year Chemistry-Based Technology Training Programs

by
Bridgid A. Backus

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I understand that my dissertation will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my dissertation to any reader upon request.

Bridgid A. Backus, Author

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Factors Related to the Economic Sustainability of Two Year Chemistry-Based Technology Training Programs

CHAPTER 1

"Since technology is the process by which humans manipulate nature (matter) for the needs and wants of society, chemistry will always be essential and chemistry-based technicians will always be needed" (American Chemical Society, 2005, p. 1). The phrase "Better Living Through Chemistry" was used in television product advertising through the 1980s. The phrase is a variation of DuPont's 1939 advertising slogan "Better Things for Better Living…Through Chemistry." The current needs of society, from plastic wrap to microchips and nanotechnology, have not diminished the relevance of those slogans in contemporary society. We need chemistry, and we need trained technicians who will contribute to "better living." Equipping the chemistry-based technology workforce will require the collaboration of industry, academia, professional societies, and workforce organizations on activities that promote the education and career development of chemical technicians (Drumm, Hinkle, & Quenzer, 2006; Frame, Leaym, Millspaugh, & Wickham, 2006; Friedman, Marine, & Neils, 2006). The chemistry-based professions are integral components of industrial research, development, and manufacturing. Community colleges, with their ability to train these professionals, find themselves connected to an endeavor that meets many essential needs of contemporary society.

During the past two decades, new technology and the globalization of business and industry have resulted in postsecondary education becoming a central aspect of workforce development. Community colleges have emerged as workforce development engines (Perez, 2007) providing the training necessary for the nation to strengthen its competitiveness in the global economy (Gruber, 2000). Professional technical training is a major component of workforce development, with nearly half of the community college degree students enrolled in professional technical programs (Lederer, 2005).

Sustaining technological education programs in community colleges is vitally important to the economic well-being of the United States. Chemistry-based technology training (CBTT) programs have become more prominent as the petrochemical, biomedical, pharmaceutical, and other industries have grown in importance. With a growing demand for products and the globalization of the manufacturing industry, our nation cannot afford to be inefficient in the development, operation, or economic sustainability of its workforce development programs. The *Executive Summary* from the Advanced Technological Education Centers Impact 2006-2007 publication (2006) stated that:

> Winning the global skills race has been identified as a critical recommendation in every recent report on U.S. economic competitiveness. As developing countries increasingly educate their workforce in science and technology, the U.S. must keep pace with the changing nature of the competition. (p. 1)

Technology training programs contribute to an important segment of the workforce development mission of community colleges. CBTT programs at community colleges provide an education that leads to well-paying jobs for employees (Rickey, 1999), profits for business and industry (Settle, 2000), community prosperity, and global competitiveness. These outcomes imply the need to recognize the significance of the economic sustainability of CBTT programs in community colleges. Once committed, community colleges have an undeniable obligation to be informed of and understand the importance of the factors necessary to sustain CBTT programs.

Research Purpose and Questions

The research topic for this dissertation is concerned with the economic sustainability of two-year chemistry-based technology training (CBTT) programs. A research problem associated with this topic is that some community colleges appear to have difficulty in sustaining their training programs. This problem leads to the purpose of my study, which was to identify, examine, and analyze the most significant factors associated with the economic sustainability of CBTT programs. With this purpose in mind, the study addressed the following three research questions:

- What is the relative importance of the identified factors relating to economic sustainability of CBTT programs?
- What differences exist between the opinions of administrators and faculty with regard to the factors associated with CBTT program sustainability?
- What are the interrelationships among the factors related to the economic sustainability of CBTT programs?

The response to the first question revealed a hierarchy of the factors identified from the literature review through rankings by program administrators and faculty. The rankings will provide focus and direction for community college personnel and business leaders toward the improvement of their CBTT training program's sustainability.

The second question's answer determined to what extent faculty and administrators agree or disagree on the ranked importance of the clustered categories of sub-factors that contribute to CBTT program sustainability. Further analyses of differences in opinions were investigated through the ratings of each of the sub-factors related to the participant’s program sustainability. Significant differences in opinions may imply different perspectives, points of view, or miscommunication leading to future investigations as to what factors are most valid in achieving CBTT program sustainability.

The answer to the third question disclosed interrelationships that led to another dimension in the study of sustainability factors. The information provided by the interrelationships will have significance beyond the current status of investigations of CBTT programs. The answer also provided clues with regard to any single factor’s ability to stand alone in significance among the complexity of factors associated with program sustainability.

Significance of the Study

The case for significance of studying factors related to CBTT program sustainability was based on six reasons: (a) There is a substantial need for chemistry-based technology training and the demand for technicians is increasing; (b) community colleges play a prominent role in providing professional technical training; (c) professional organizations have expressed a need for research into the factors that have an impact on professional technical and CBTT program sustainability; (d) there is a scarcity of literature on factors relating to CBTT program sustainability; (e) there may be differing opinions between faculty and administrators involved in programs; and (f) I have a personal interest in professional technical training and chemical education.

Increasing demand for chemistry-based technicians. As international competition increases, industry has turned to the community colleges to develop programs that will increase the skill level of the professional technical workforce. Federal and state governments have invested substantially in community colleges to provide technical education (Bradley, 2006) and training in high performance occupations (Jacobs & Voorhees, 2006) such as science technicians. Of the 267,000 science technicians employed in 2006, 61,000 were chemical technicians (U.S. Department of Labor, 2008). The remainder includes biological, environmental, health, agricultural, food science, geological, and nuclear technicians. All of these professions require various amounts of education and training in chemistry. The employment growth of science technicians has been projected to increase as fast as the average, approximately 15% through 2012, when compared to all other jobs in the U.S. (American Chemical Society, 2005; Marasco, 2005). It is also expected that there will be an increase in jobs as chemical plant systems operators (Engelman, 2005).

Insufficient numbers of graduates from CBTT programs and attrition will impact the job market as the retirement rate of chemistry-based laboratory technicians is expected to increase (Aronson & Wesemann, 2007). As baby boomers retire, it is anticipated that there will be a shortage of chemical technicians in the coming five to 10 years (Dalton, 2004). This shortage will result in many new openings for trained personnel, and it is the community college that will be able to provide skill-based programs that can prepare more knowledgeable workers (Jacobs & Voorhees, 2006).

Training potential of community colleges. Community colleges are increasingly recognized as educational institutions that are most able to identify changing local labor conditions and to provide training geared toward the jobs in demand (Perez, 2007). The theme of workforce and economic development, including technical careers, now appears in a significant number of community college mission statements (Ayers, 2002). To train their present and future employees, industry and government officials are looking to community colleges for their nimbleness (Bradley, 2006), geographic proximity, quality of education, and affordability (Zinser & Lawrenz, 2004). Modern community colleges have a major responsibility for preparing the nation's current and future professional technical workforce. Dougherty and Bakia (2000) pointed out that to attract and retain industry, state governments have mandated community colleges to play a central role in workforce preparation and have provided funds for this purpose. To accept workforce development as part of their mission, community colleges must be responsive to their community, business and industry, and professional organizations who are asking them to take an important role in establishing and sustaining professional technical programs, such as CBTT.

Verification of factors related to program sustainability. The American Chemical Society's ChemTechLinks project, supported by the National Science Foundation (NSF), sponsored a conference in 2004 as part of its mission to support CBTT programs. The conference gave rise to a report that identified several critical issues related to the sustainability of CBTT programs (American Chemical Society, 2006b). This report indicated a need for further exploration of the issues and stated: "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?" (p. 3). Post-conference contact with staff at the American Chemical Society (ACS) has indicated continuing interest in this topic. The Assistant Director for Higher Education, Jodi Wesemann (personal communication, December 28, 2006), stated "There are many questions that we at ACS and our colleagues involved with the NSF-Advanced Technological Education (ATE) program are interested in having answers to, or at least more insights into."

A report by the Community College Research Center (Bailey, Matsuzuka, Jacobs, Morest, & Hughes, 2004) asserted that a broad research agenda is needed to explore the best ways to combine academic and technical instruction, both to meet the needs of the job market and to prepare students for subsequent education. Governmental agencies commonly report on the role of community colleges in professional technical training, but research on how to identify and analyze factors associated with sustainable programs is meager.

Insufficient research and literature. Community college involvement in new economic development activities is quite widespread, yet data on the impact of this new role on trainees, firms, and colleges are relatively scarce (Dougherty & Bakia, 2000), suggesting that more research is needed. There is a scarcity of literature in the area of professional technical training program improvement and evaluation, as well as other variables affecting sustainability. Jacobs and Voorhees (2006) claimed that too little data currently exist concerning how community colleges can promote and facilitate workforce transitions that will assist in developing more effective practices in training programs. Furthermore, the authors recommended that additional effort is needed to help institutions, researchers, and policymakers understand their critical roles in workforce development programs. These roles may be among the most significant factors associated with the success of CBTT programs.

A report issued by the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the International Labour Organization (ILO) (2002) recommended that:

> National policy should foster research related to technical and vocational education, with particular emphasis on its potential within lifelong learning, and directed to its improvement and relevance to the prevailing socio-economic context. (p. 16)

The ATE program, funded by the NSF, is one of the best known technical education programs. This program focuses on two-year colleges and expects them to take a leadership role in their projects. According to the ATE (National Science Foundation, 2006), activities undertaken in support of their projects include research on the effectiveness of various approaches and practices in technical education. Bailey, Matsuzuka, et al. (2004) pointed out the need for research that tracks the experience of advanced technological education activities after NSF funds are either discontinued or reduced. These funding changes may have a significant impact on the sustainability of CBTT programs.

There are a variety of factors associated with sustaining technology-based training programs, but most research is related to organizational change and based on personal experience rather than empirical studies (Lawrenz, Keiser, & Lavoie, 2003). However, some definitive factors have been identified in studies involving ATE programs. In an assessment of all current ATE programs, Lawrenz, et al. (2003) contended that educational technology projects should focus on collaboration, program development, accountability, professional development, marketing, and having ongoing vision as the primary factors of sustainability.

Certain factors associated with the current study have been identified or recognized by professional organizations as requiring more research, but with the exception of ChemTechLinks (ACS, 2006b), ACS Websites, and a Partnership for the Advancement of Chemical Technology (PACT) research profile study, relatively little specific research concerning CBTT programs was found in the review of literature. The ACS's Jodi Wesemann (personal communication, December 28, 2006) stated: "I don't think that much research has been done in community perceptions and marketing, at least not in chemical technology." The sustainability of a CBTT program may be adversely affected if it is not marketed appropriately. In addition, if the community's perception of the chemistry-based profession and its associated training are not positive, program sustainability may be affected. In order to provide insight into this subject, the current study examined each program's ratings of marketing and community perception with respect to its sustainability.

The scarcity of literature in CBTT indicates a serious gap in the research concerning the sustainability of successful professional technical training programs. The intent of this study of the factors related to the sustainability of CBTT programs is to add scholarly research to the limited amount of existing knowledge. In addition, the current study presents information that may assist college administrators and faculty, business and industry personnel, and government leaders in making sound decisions with respect to a CBTT program's sustainability.

Differences in opinions of administrators and faculty. Analyzing differences of opinions of administrators and faculty may provide greater understanding of the factors related to CBTT program sustainability. Skolits and Graybeal (2007) found that administrators and faculty differ in their knowledge, support, participation, and perception of strengths and weaknesses of institutional effectiveness. If both administrators and faculty are to be full participants in arriving at satisfactory outcomes for professional technical training programs, each must understand the problems which face the college as a whole, as well as different perspectives of each other.

Instructors are more accountable to students, while administrators are held responsible to the demands of the general community. This division may cause not only the isolation of instructors and administrators, but also promote animosity between them. Campbell and Slaughter (1999) pointed out that some tension between faculty and administrators is part of academic life, but few studies have empirically explored differences between the two groups when industry is involved.

Administrators that come from an academic setting are not knowledgeable about teaching in professional technical programs (Grubb, et al., 1999). Without an understanding of the professional technical training classroom and instructional issues, there may be differences of opinions regarding the importance of partnerships, goals, resources, and the promotion of programs. In addition, many faculty members admit to having little understanding of administrative motivations and pressures.

Differences in responsibilities, expectations, and control issues may also contribute to possible disagreements between administrators and faculty.

Professional technical training programs are often faced with fiscal problems because some administrators favor programs that take in more revenue, thus reducing resources that may affect instructor workloads, partnership building, instructional equipment and instrumentation, and curriculum development (Grubb, et al., 1999). As mentioned earlier, the current study examined whether or not significant differences exist in the opinions of administrators and faculty. More specifically, this study analyzed opinion differences on fiscal issues which may assist in improved leadership and management of CBTT programs.

Personal interest and experience. My professional career has positioned me to understand the significance of this study through the lenses of a community college instructor, the Physical Sciences Department Chair, and as a participant in designing and implementing a customized CBTT program in which I was the primary chemistry instructor. Given the fact that these programs are complex endeavors, it is significant to the leadership of community colleges to become competent in evaluating whether or not their college has the ability to sustain such programs. In the future, I would like to develop a sustainable chemistry-based training program for my college, as well as assist other colleges in establishing such programs. Finally, as a long-time member of the ACS, one of my goals of this dissertation research is to assist the organization in its desire to further investigate the factors associated with the sustainability of CBTT programs.

Summary

Acknowledging that community colleges are the primary providers of technical training in the U.S., the purpose of this study was to identify, examine, and analyze the most significant factors associated with economic sustainability of CBTT programs. With this purpose in mind, the current study addressed the following research questions: (a) What is the relative importance of the identified factors relating to economic sustainability of CBTT programs? (b) What differences exist between the opinions of administrators and faculty with regard to the factors associated with CBTT program sustainability? (c) What are the interrelationships among the factors related to the economic sustainability of CBTT programs?

The need for research into the factors related to the sustainability of CBTT programs has been recognized and documented by professional organizations, business and industry, governmental agencies, and community colleges. The significance of my research is based on six supporting arguments: (a) There is a substantial need for CBTT and the demand for workers is increasing, (b) community colleges play a prominent role in providing technical training, (c) professional organizations have expressed an interest in further research into the factors that have an impact on technology training program sustainability, (d) there is insufficient research in sustainable CBTT, (e) knowing the differences in opinions of faculty and administrators will improve community college leadership in sustaining programs, and (f) this study will enhance my expertise as a community college leader. It should be noted that this study did not investigate issues related to supply and demand of chemistry-based technicians. The results of the current study will assist individuals in professional organizations, business and industry, governmental agencies, and college personnel in making sound decisions for CBTT programs. The bottom line is that chemistry-based technicians must be well-trained to ensure industry's productivity. Given the impending need for more and better trained technicians, the sustainability of training programs is an important contribution to our notion of "Better Living Through Chemistry."

CHAPTER 2

Literature Review

The objectives of this chapter are to provide support for the design of the current study, a rationale for the variables, and the background for the operational definitions used in this research. The areas of focus include: (a) a description of the chemistry-based technician profession, (b) the meaning of economic program sustainability, and (c) the four clustered categories of factors related to program sustainability. The first section provides a description of chemistry-based technician jobs, responsibilities, and training needs and includes literature that applies to two-year college CBTT programs. The second section includes some interpretations of the term sustainability which assisted in the development of this study's operational definition of sustainability. The purpose of the third section of the literature reviewed is to discuss specific factors related to the sustainability of CBTT programs with respect to: (a) partnerships, (b) employer and student educational goals, (c) faculty and their resources, and (d) community perceptions and marketing strategies. The summary of the literature review presents background for the current study into the relative importance and interrelationships of the factors influencing CBTT program sustainability. Two fundamental questions were used to direct the literature review:

1. What does the current literature indicate about the participants and practices related to the sustainability of professional technical training programs?
2. What does the current literature indicate specifically about the sustainability of CBTT programs in community colleges?

These overarching questions provided the basis for an exploration of literature that was related to the research purpose and questions proposed in my study in addition to: (a) Achieving an understanding of the problem, (b) formulating a research design, and (c) providing valid answers to the study's research questions.

A catalyst for gathering information for this chapter originated in the ChemTechLinks report, "Critical Issues and Effective Practices in Chemistry-Based Laboratory Technology Education" (ACS, 2006b). Using the report as a starting point, I assembled a list of terms and keywords as a launch into the search for literature on professional technical training programs in general, and more specifically, CBTT programs. The Oregon State University library was used to search for relevant studies related to CBTT programs and sustainability. The approach to the literature review began with a search of the library's online databases (i.e., ERIC, Dissertation Abstracts, E-Journals, and Academic Search Premier). Yahoo and Google search engines were also used. The following key words and their variations, singly and in combination, were used: alliances, chemical, community college, education, faculty, leadership, marketing, partnerships, programs, technical, technician, technology, training, sustainability, vocational, and workload. Relevant articles, Web sites, dissertations, and books were identified from this search. Other literature sources were obtained from the bibliographies of documents, conference abstracts, and attendance at national ACS conferences.

A thorough review of the literature was made to identify meaningful observations, data analyses, and interpretations that contributed to the topic of sustainability of CBTT programs. There were two general elements of research selectivity that encompassed the criteria for this review: the relevance of the topic and the currency of material. Literature on the subject of workforce training was regarded as current if its date of publication was after or inclusive of 1984, the year the Carl D. Perkins Vocational and Technical Education Act was authorized by Congress. Priority was given to articles on professional technical training published after or inclusive of 1993, the year ATE programs were initiated by the NSF. In 2000, representatives of the U.S. Department of Education's Office of Vocational and Adult Education asserted that the concepts of vocational education had grown outmoded and should become one of the core missions of community colleges (Jacobs, 2001). As a result, top priority was given to articles on professional technical training published after and inclusive of the year 2000.

Chemistry-Based Technicians

The following is an overview of the community's perception of chemistry-based technicians, their job responsibilities, and their training needs. This section discusses how the changes toward more complex responsibilities of technicians have contributed to a higher regard for their profession, the role of community colleges in meeting industry's CBTT needs, and representative curricula of CBTT programs in the U.S. In order to study the issues associated with CBTT program sustainability, it is necessary to have an understanding of the chemistry-based professions and their technology training programs.

Professional Status

Chemistry-based technicians have a variety of titles, such as Associate Scientist, Associate Chemist, Analyst, or Technologist (Moore, 2008). Other titles include Chemical, Engineering, Environmental, Analytical, Mechanical, Drafting, Science, and Biological Technician. Thus, even if the title of the job does not actually say "Chemical Technician," the position is still considered to be a chemistry-based technician. Unlike some professions, chemistry-based technicians have had a difficult pathway leading to a respected position in the community and industry. Originally, chemistry-based technicians were often regarded as low-skilled workers with a nonprofessional status. The professional status of chemistry-based technicians improved when the ACS's Committee on Technician Affairs was established in 1964, followed by the formation of affiliate groups and meetings of chemical technician leaders at national meetings in the 70s and 80s (Engleman, 2004). By 1994, the Division of Chemical Technicians (TECH) was established as a full division of the ACS, and, in 2001, an ACS bylaw was changed to give full membership to chemical technicians having a two-year associate's degree and five years of work experience (Dalton, 2004). This culminated the efforts of chemical technicians to attain a deserved professional standing in the chemical industry. The perception of chemistry-based technicians by the community may be a significant factor associated with the sustainability of CBTT programs. A misconception of the profession may lead to reduced program enrollments followed by possible program budget reductions and threats to sustainability.

Technician Duties

Chemistry-based technician jobs can range from basic research to hazardous waste disposal. There are generally two main types of chemistry-based technicians: laboratory and process. Laboratory technicians conduct a variety of procedures, from simple chemical techniques to complex research projects (Dalton, 2004), including biotechnology, water treatment, and environmental testing. Research and development laboratory technicians may work in a laboratory, pilot plant, production, or safety (Moore, 2008). Moore also indicated that process technicians work in manufacturing and other industrial settings and operate the machinery that manufacture paper, petrochemicals, food products, polymers, paints, soaps, coatings, and pharmaceuticals (Marasco, 2005). All chemistry-based technicians, regardless of their type, provide support and expertise in data management and quality control. The job setting for each type of technician may be different, but training in basic chemistry, mathematics, laboratory, and communication skills is similar. All chemistry-based technicians share the common goals of using safe practices, developing teamwork, and learning the chemical principles and laboratory skills covered in CBTT programs.

Recently there have been considerable changes in responsibilities and expectations for chemistry-based technicians. The workplace environment for technicians is changing because of a combination of scientific, economic, and societal reasons. New technology, economic uncertainty, and the changing patterns of businesses and globalization are factors in this change (ACS, 2005). Chemistry-based technicians are no longer confined to traditional laboratory assistant roles but are now members of industrial teams, participating in projects, operating and maintaining sophisticated equipment, and performing chemical analyses (Marasco, 2005). With the rapid advancement of technology, job training in a specific chemical laboratory technique or instrument will not adequately prepare technicians (ACS, 2005). Today's technicians are not the same as they were 25 years ago, and according to John Engelmann, former ACS Chairman of the Committee on Technician Affairs,

> Technicians are no longer just a pair of hands. The biggest change I've seen is they're now part of the team, running the lab portion of the job and reporting the data. As a result, technicians have more autonomy, responsibility, and accountability than they had in the past. (Marasco, 2005, p. 50)

The Role of Community Colleges in Technician Training

Community colleges have always provided career and technical education, but there is an increasing sense of urgency to work with individual industries to offer content-specific courses (Zinser, 2003). The manufacturing industry echoed this sentiment from their perspective by stating, "Community colleges and technical institutes have become central to innovative practices in educating and training the workforce, both current and future" (Eisen, 1997, p. 20). The chemical industry acknowledged that these innovative practices require that new hires must come into the workforce with fundamental skills in mathematics, chemistry, computers, and communication (Dalton, 2004).

A prepared workforce is essential for the economic and scientific competitiveness of chemistry-based industries (Aronson & Wesemann, 2007). The chemical industry has a vested interest in nurturing and maintaining the chemical technician workforce (Settle, 2000) and the main source for the education of technicians is two-year colleges (NSF, 2006). Career and technical programs offered at community colleges are especially important in today's rapidly changing job market (Zinser & Lawrenz, 2004).

To be successful and accredited, CBTT programs at community colleges must focus on the needs of industry and students, while incorporating program and skills assessment. Community colleges also need to provide the "soft" skills for prospective chemistry-based technicians. Among the most important tasks will be to develop critical thinking and communication skills, and instill the attributes of teamwork, flexibility, safety consciousness, and an appreciation for lifelong learning (ACS, 2005). Providing this comprehensive education is one of the many challenges facing community colleges in their quest for sustainable CBTT programs.

Community College CBTT Programs

Chemistry-based technology training programs prepare students for careers as chemical technicians or other related professions. According to Aronson (2008) "To ensure the success of their graduates, such programs typically work closely with industry and the community, incorporating their needs into the curriculum" (p.11). The Directory of Chemistry-Based Technology Training Programs (ACS, 2007) listed 160 CBTT programs with about 90% of these programs in community or technical two-year colleges. Four regions in the U.S. represent the programs: (a) Northeast, (b) Gulf Coast, (c) Western, and (d) Great Lakes. Twelve of these programs were ACS-approved, reflecting competencies instituted by the ACS Chemical Technology Approval Service. This service is one of the ACS projects focused on technician education. Another is the ChemTechLinks project supported by a National Science Foundation Advanced Technological Education (NSF-ATE) grant (DUE 0053250) and the Education Division of the ACS. The goals of the ChemTechLinks project are to support and advance chemistry-based technician education in the United States by:

(a) Building on existing chemistry-based technician education activities, (b) communicating with those involved in related activities at local and national levels, and (c) establishing a foundation upon which new activities that support excellence in two-year college chemistry-based technical education can be developed (ACS, 2006b). The project is also concerned with improving the preparation of technicians and sustainability of programs by supporting better skill standards, facilities, and instructional methods.

CBTT programs vary, but a representative curriculum includes coursework leading to a basic knowledge of mathematics, chemical, and other scientific concepts, along with laboratory proficiency, computer competence, safe and efficient work practices, and inter-personal and communication skills (Florida Department of Education, 2006). CBTT programs also include education in the following general competencies expected in the modern chemical industry: knowledge of underlying principles of technology, planning, time management, health, and environmental issues (Delta College, n.d.). Sixty-four semester credit hours is the standard length for a chemical technology training program leading to an associate of science (A.S.) or the associate of applied science (A.A.S.) degree. Educational achievement, in the form of a degree or certificate, as well as other student goals, was investigated in the current study of the sustainability of CBTT programs.

Summary

This section provided a description of the types of chemistry-based technicians, their job responsibilities, and the content of a typical CBTT program curriculum. The evolution of chemistry-based technicians as a profession was discussed along with the support of this status by professional organizations. Emerging responsibilities and expectations for chemistry-based technicians were discussed, as well as what community colleges do to provide education to meet the training needs of students and industry. The issues identified in this section that have implications for program sustainability include curriculum design, chemistry-based course content, the status of chemical technicians as a profession, and meeting industry's needs in today's changing global market. These issues provide support for the current study's selection of factors having an impact on program sustainability.

Economic Program Sustainability

The research directly related to program sustainability is scarce, despite its importance to technical education programs (Cuban, 2000). Studies on sustainability applicable to professional technical training programs are uncommon, indicating a "gap" in the literature and an area of needed research. The gap suggests that the current study will contribute to the further understanding of the meaning of sustainability as it relates to CBTT programs.

The purpose of this section of the literature review is to present and clarify various definitions of sustainability currently used in the literature. Brief descriptions of environmental, social, and economic sustainability, followed by traits associated with sustainable programs are described in order to provide contextual and background information for the study. In addition, an operational definition of economic program sustainability, as it relates to the current study, is provided in the summary of this section.

Sustainability is a concept with far-reaching implications-- influencing individuals, organizations, society, and the earth as a whole. Sustaining the environment is a topic of major concern throughout the physical and biological world. Goodland (2002) asserted that environmental sustainability refers to keeping renewable and nonrenewable resources within regenerative capacities and maintaining output of waste within the assimilative capacity of the environment. He also stated that social sustainability applies to creating shared rules, laws, values, and information between individuals that lead to equal rights and well-being. Finally, Goodland referred to economic sustainability, as it pertains to programs, as the continuance of activities that result in the fulfillment of the capital needs of individuals, institutions, and organizations. Economic sustainability refers to a program's ability to operate in a manner that allows continued existence over time, with a persistent return to participants. Although the basic ideas of environmental, social, and economic sustainability are different, there may be some commonality in how the characteristics of one type have an effect on the others. For example, both collaboration and trust are features of social sustainability, but they also may contribute to the economic sustainability of a program. An example of how environmental and economic sustainability overlap is found in chemistry laboratories. According to John Newey, a longtime community college chemistry instructor, years ago much of the waste generated by laboratory experiments was simply washed down the drain (personal communication, December 20, 1999). This researcher's personal experience as a chemistry laboratory instructor has shown that current concerns for the environment have improved the methods of the disposal of chemical waste. However, this improvement comes with a price. According to Rice University's Environmental Health and Safety Department, "…the cost of chemical waste disposal in some cases is two to three times the purchase cost of the chemical" (Rice University, n.d.). The expense of disposing of chemical waste may be an area for future investigations in CBTT program sustainability.

In a broad context, sustainability refers to a program's continuation or its permanence (Shediac-Rizkallah & Bone, 1998). However, permanence should not be confused with institutionalization, which is the process of assimilation into an organizational structure. Akerlund (2000) suggested that a sustainable program is one that must exhibit high quality, provide data to document success, be community-based, and meet funding priorities. Program sustainability can be even more simply defined as the ability to prolong or to supply with sustenance (Lawrenz, Keiser, & Lavoie, 2003). In a study of training programs, Scheirer (2005) listed five important factors that influence the extent of sustainability: (a) A program can be modified over time; (b) a "champion" is present; (c) a program "fits" with its organization, mission and procedures; (d) benefits to staff members or students are readily perceived; and (e) stakeholders in other organizations provide support. Scheirer found substantial convergence on the aforementioned major influences and suggested that project sustainability is possible, under the right conditions, by a blending or interrelationship of factors. Scheirer further suggested that future studies on influences on sustainability should start from a broad conceptualization of these factors. She referred to the research of Shediac-Rizkallah and Bone (1998) that distilled three major factors from a review of literature as potential influences on sustainability. The researchers interconnected the factors into a framework for conceptualizing program sustainability including: (a) project design, (b) factors within the organizational setting, and (c) factors in the broader community environment. This framework is consistent with the four clustered categories I have developed for the current study. Scheirer's research pointed out the significance of determining the relative importance of factors and the interrelationships, suggesting the appropriateness of the design for the current study of CBTT program sustainability.

Economic program sustainability is relevant to the education and training programs of the chemistry-based workforce. It has been found that some of the CBTT programs in operation in the early 2000s are no longer in operation (ACS, 2006a). While establishing a training program is one issue, keeping one in existence is a different issue. People involved in technical training programs want a more practical definition of sustainability. They want to know if and why "their" program will endure (Altman et al., 1991). This implies that individuals facilitating technical training programs need to understand the relative importance of the factors and their interrelationships associated with program sustainability.

Summary. This section of the literature review provided a foundation for understanding the differences and overlapping characteristics among environmental, social, and economic program sustainability. As a result of the literature reviewed, several defining features for sustainable professional technical programs became evident. Sustainable programs are viable over time, are flexible, fit an organization's mission, have a "champion," and engage and benefit stakeholders. These features were included in the framework used in this study to determine the significant factors associated with CBTT program sustainability. Finally, the literature assisted in the development of the definition of economic program sustainability, as it pertains to CBTT programs. For the current study, economic program sustainability was defined as referring to continued program activities with observable benefits or outcomes for stakeholders. Henceforth economic program sustainability will be referred to as sustainability.

Factors Associated with Program Sustainability

The factors identified in this subsection of the literature review provided the foundation for my research design in the determination of the relative importance and interrelationships of the variables influencing CBTT program sustainability. The purpose of my study lies in identifying, determining the relative importance, and analyzing the interrelationships among the factors that contribute to the sustainability of CBTT programs. Two principal research studies were used to gain insight into the individuals, careers, and issues associated with chemistry-based training programs: the PACT survey (Stander, et al., 2000) and the ChemTechLinks survey (ACS, 2006b).

The individuals involved in the multifarious challenges of CBTT programs, including students and instructors, have diverse backgrounds that may influence program sustainability. The current study used the PACT Research Profile Study (Stander, et al., 2000) to develop an understanding of the learning and teaching styles, personality traits, attitudes, and values of chemistry-based technology students, instructors, and practicing technicians. The study was intended to provide information for future curriculum and materials development, recruiting, and retention for program participants.

In the PACT survey, about 200 students from 16 two-year and four-year colleges provided profile information and completed the Myers-Briggs Type Indicator and the Grasha-Riechmann Learning Styles Inventories. The students were also asked about their expectations and opinions of the chemical technician profession. Survey packages were sent to about 950 instructors, of which 60 responded. The survey included questions about types of programs, ties to industry, equipment usage, and opinions of instructors regarding their students. Additionally, a teaching styles inventory was administered and statistically analyzed. Practicing chemistry-based technicians were asked about their backgrounds, attitudes, skills, and career aspirations. Of the 850 chemistry-based technicians surveyed, 197 responded. The survey used Likert scale responses to rate personality characteristics and perceptions of their profession. Although the response rates for all of the participants were low, the breadth of topics covered proved invaluable by providing an understanding of the characteristics and aspirations of CBTT program faculty, students, and graduates.

The selection of factors for this section of the literature review was primarily based on the findings at the 2004 ChemTechLinks conference. The conference’s 27 participants came from high schools, two-year colleges, industry, and government. The conference participants identified 13 critical issues affecting CBTT programs and causal factors influencing these issues. Subsequently the conferees combined several related issues from the 13 to form a list of nine (ACS, 2006b):

- 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 report did not provide information with respect to how or why the related issues were combined.

The nine issues were explored further in a subsequent survey in 2005 by ChemTechLinks that was sent to all known CBTT training programs in 35 states, the District of Columbia, American Samoa, and Puerto Rico. The results of this survey were contained in the NSF supported ACS report, "Critical Issues and Effective Practices in Chemistry-Based Laboratory Technology Education," (ACS, 2006b).

Although the ChemTechLinks report was informative, comprehensive, and well-organized, a variety of limitations were apparent. Since the survey was structured around the fundamental concerns of the conference, it was essential that the meanings of "critical issues" and other terminology were clearly understood by the participants. A post-conference participant survey indicated some concern with the definition of terms. In order to limit confusion in the meanings of terms, the current study formulated and provided operational definitions for all of the variables used in the survey.

Another limitation of the ChemTechLinks research existed in the ability to generalize the data for CBTT programs given that there were only 27 respondents to the nation-wide survey despite the fact that thank you gifts from the ACS were offered for participation. Considering the low response rate of the ChemTechLinks research, the current study took additional steps to ensure a greater participation by contacting individuals directly and performing several follow-up requests.

The ChemTechLinks report indicated that the survey was sent to training programs around the country but did not specify the job position of the contact. It is a fair assumption that the individual was the program director/coordinator, but oftentimes surveys are frequently forwarded to others within the institution, as was the case with the current study. Furthermore, the report did not specify whether the respondent was an administrator or faculty member. As mentioned earlier, differences in opinions of faculty and administrators oftentimes exist, which is why the current study addressed this limitation by requesting participation from both groups.

Although the ChemTechLinks research inquired about the number of students in their programs, the study did not differentiate between responses according to the size of a program. Smaller programs may respond differently according to their needs than larger programs. After evaluating the acquired survey data, the current study evaluated whether or not there were significant differences in the responses according to the size of the program, which was defined by the number of students enrolled.

Another limitation in the ChemTechLinks survey was sampling bias. Of the 27 respondents, 35% had programs that were ACS approved, however only 14% of all CBTT programs nationwide had such approval. This leads one to believe that there was a potential for bias in that ACS approved programs may have different interests, standards, and operating procedures than other programs. In addition, bias was introduced by the geographical demographics, which indicated a non-representative sample of CBTT programs. The report included the following geographical distribution of the number of respondents to the survey: Northeast had 11, Great Lakes had three, Gulf Coast had two, and Western had two for a total of 18 respondents. The assumption would be that the other nine respondents were scattered outside the four regions; however no mention of this was in the report. In order to obtain a representative sample, according to the Directory of CBTT Programs, the approximate representative percentages within the four regions should be 25% Northeast, 22% Great Lakes, 20% Gulf Coast, and 12% Western. This indicated further potential bias with regard to the critical issues selected and relative rankings of importance. The current study attempted to alleviate this bias by obtaining a representative number of respondents from the various regions of the country.

Approximately 60% of the program participants responding to the survey had more than one CBTT program offered at their college. Colleges with multiple programs could be confronted with issues of greater complexity than programs more concerned with fundamental operation. This complexity could be reflected in the perceptions of the respondents and potentially result in some bias in assessing the factors affecting sustainability. To help alleviate this bias, the current study asked participants to respond to survey statements as they relate to their specific program's sustainability.

The ChemTechLinks survey was primarily designed to gather nominal data used in descriptive statistics in the form of percentages illustrated by bar graphs. In order to provide greater insight into the issues affecting CBTT programs, the current research examined the topic of sustainability with respect to some of the issues identified by ChemTechLinks. In addition, the current study used ordinal and interval scale data for descriptive, associational, and inferential statistical analyses.

In summary, information from the ChemTechLinks report was important to the current study, because it provided a list of identified issues important to building effective and responsive programs. The issues were synthesized from reputable representatives of industry, government, and education. The identified issues from this previous study were evaluated by this researcher along with the review of other related literature in order to determine the factors or variables to be analyzed in the current study. In addition, the ChemTechLinks report explored the underlying factors that contributed to the importance of program characteristics. For the current study, this information was invaluable in making decisions regarding the nature of the factors to be investigated.

In the same way the ChemTechLinks project leaders combined related issues, I found areas where the nine identified issues could be clustered and condensed into four major clustered categories of factors, see Figure 1 below. For the current study, I believed combining these issues, based upon their substantive connectivity, was possible without omitting or diminishing the significance of any factor related to program sustainability. For example, due to their overarching connection with employment, aspects of the ChemTechLinks' critical issues that included professional technical program recruitment, retention, placement, and employability skills, were clustered into the category of Employer and Student Educational Goals.

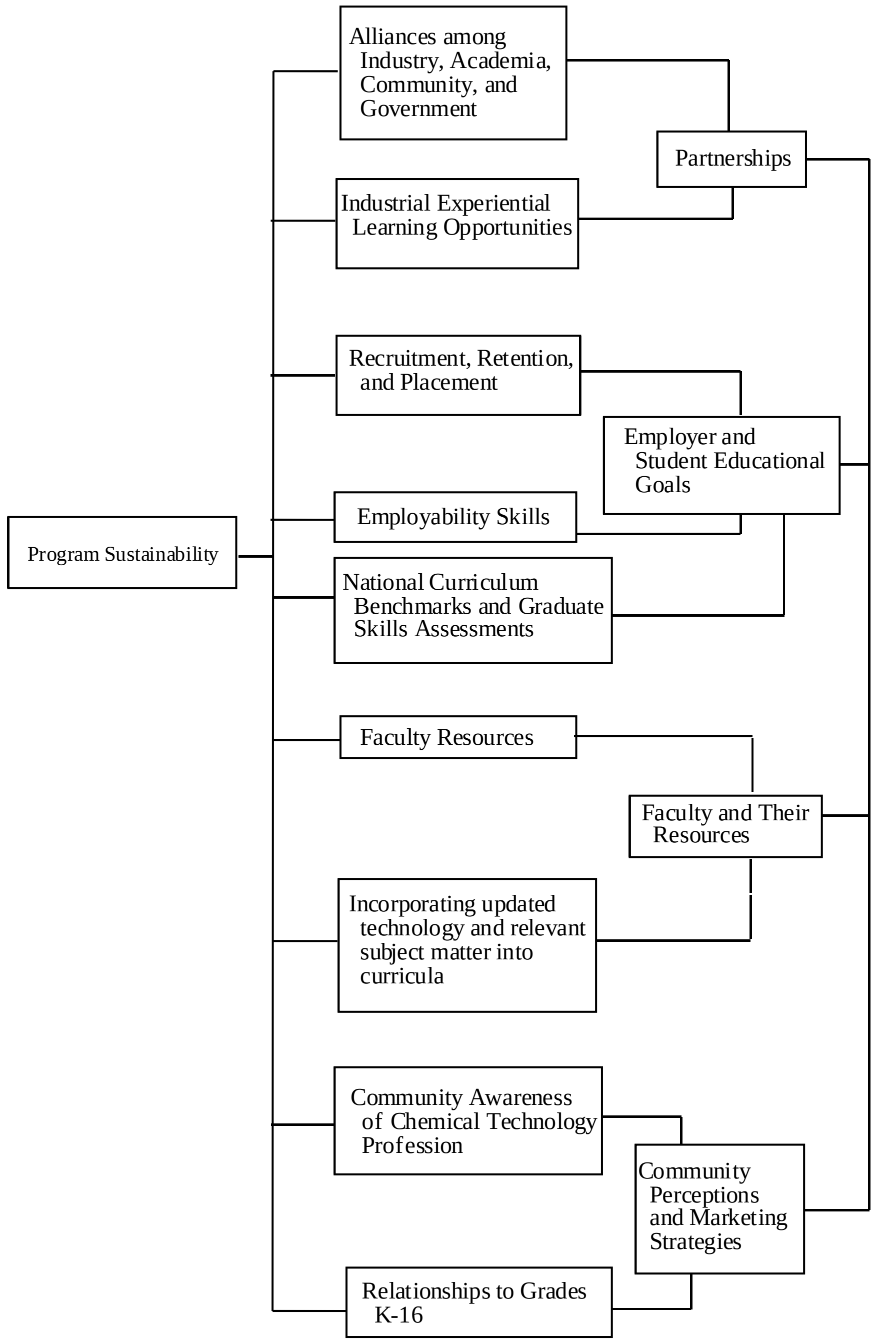

Figure 1: ChemTechLinks nine critical issues condensed into four clustered categories.

The literature reviewed in this section is organized by the four broad-based clustered categories or independent variable clusters: (a) partnerships, (b) employer and student educational goals, (c) faculty and their resources, and (d) community perceptions and marketing strategies. The content of the four sections provided the rationale for clustering the nine categories identified in the previous research into the four categories used in the current study. In the current study, a conceptual framework was used to formulate the four clustered categories with their associated sub-factors relevant to CBTT program sustainability, see Figure 2. In addition, this framework was used in the development of the data collection instrument.

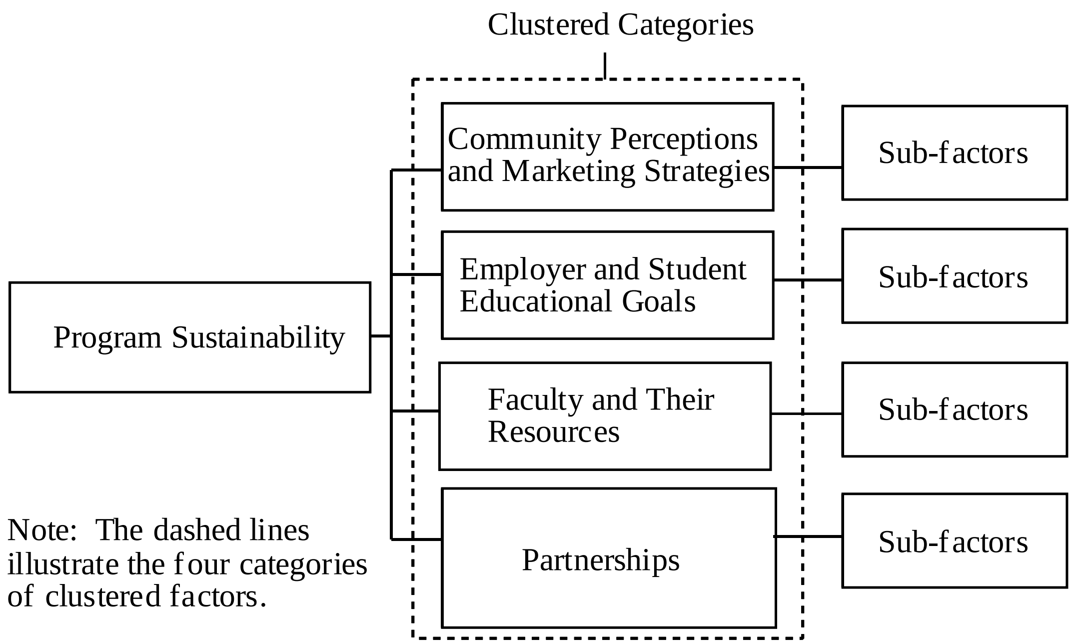

Figure 2: Clustered categories and their sub-factors relating to CBTT program sustainability.

The following sections of this review of literature will discuss each of these clustered categories of sub-factors.

Partnerships

One of the clustered categories that has drawn attention in the community of CBTT programs was the relationship of partnerships to sustainability. The ACS, in their report, "Science Educational Policies for Sustainable Reform" (ACS, 2004), urged community colleges to provide incentives to foster partnerships with employers for the training and retraining of the community's workforce. In the realm of workforce development, partnerships provide the links that bond community colleges with business and industry.

The purpose of this subsection is to identify and describe factors related to partnerships between community colleges and business and industry which may pertain to the sustainability of CBTT programs. Included are descriptions of some of the characteristics of partnerships, methods used to build and sustain them, and some of the obstacles encountered in associations between educational institutions and employers. Investigating these aspects assisted in the determination of what data were needed and guided the design of the current study's data collection instrument. Understanding the relative importance of the identified factors will assist programs in determining where stakeholders need to focus their efforts in order to sustain programs. Evaluating possible interrelationships will provide an even deeper understanding of the factors and assist participants in partnerships to decide where to direct their resources (i.e., time, money, personnel, or space).

One underlying theme in partnerships was that community colleges have been able to combine attributes such as expertise, capacity, and credit-bearing courses in a well-established and easily accessible institution (Gruber, 2000). Spangler (2002) argued that there was no one process to follow in establishing successful partnerships, but that all partnerships have some common elements: economic benefits to the partners, the involvement and commitment of the institution's leadership, and direct benefit to students. It was her opinion that partnerships survived only as long as they were efficient, productive, profitable, and outcome-based for the partners. Spangler also stressed that there were no guarantees for successful partnerships, but that openly sharing goals and dealing up front with problems were essential.

Partnerships required the cooperation of many individuals and required a joint effort that included faculty, college administration, and business and industry representatives. The following subsections describe characteristics of partnerships related to CBTT program sustainability, such as the roles of business and industry, community colleges, leadership and administration, collaboration, and industrial experiential opportunities.

The Role of Business and Industry in Partnerships

The purpose of this subsection is to provide background information that will assist in the understanding of the current role of business and industry in professional technical education partnerships. Professional technical education is complicated by the creation of a distinction between "education" and "training" that was established by the federal government in the early 1960s (Grubb, 1999a). The evolution of the role of partnerships on workforce development has caused a significant change in that distinction. The role of business and industry in education has changed from involvement and expectation, to advisement, and finally to partnership. In the first half of the 20th century, workforce development was altered due to a change in focus on collaboration between postsecondary education and the business world. Business and industry was often involved in the decision-making process in the early two-year colleges, but in the post-World War II era it became less acceptable for business to have input, so involvement was defined and limited to an advisory role (Cochran, Phelps, & Cochran, 1980). As political, economic, and social pressures created a movement toward more collaboration between corporations and nonprofit organizations (Austin, 1999), the number of partnership collaboration agreements increased, along with their complexity (Kisner, Mazza, & Liggett, 1997). Partnerships developed to help compensate for the shift of involvement by government and public organizations into the private sector.

The current study analyzed CBTT program sustainability with respect to the role (i.e., advisement or collaborative) of business and industry in partnerships. Some CBTT programs' sustainability may be dependent upon the presence of a partnership and the role business and industry plays. Gruber (2000) claimed that some community colleges have emerged as "stars" that employers will seek out as partners to meet their expanding training needs. Partnerships have contributed to the success of certain training programs involving community colleges, the general community (Spangler, 2002), business (Sundberg, 2002), and the chemistry-based technology industry (Gibbs, 2005).

In summary, the relationship between business and industry and colleges providing workforce development has changed from a peripheral involvement to one of the partnerships featuring greater shared decision-making and collaboration. The current study investigated the contribution of partnerships to the sustainability of CBTT programs.

The Role of Community Colleges in Partnerships

The purpose of this subsection is to describe the role of the community college in partnerships with business and industry. College awareness and responsiveness to the workforce needs of its community are addressed. Additionally, a process of establishing and maintaining partnerships with business and industry by the community college is included. Finally, how college mission statements reflect new workforce needs and market-responsiveness is presented.

According to MacAllum and Yoder (2004), over the next few years community colleges will become increasingly more important partners with states, local school systems, and local employers. Furthermore, community colleges will become more involved in building rigorous lifelong learning systems that work for both students and local economies. However, partnerships should not be created as a quick fix, or an easy solution to an old problem, but rather should be created to address new, emerging issues (Sundberg, 2002), including: (a) flexibility of curriculum and scheduling, (b) creative funding, and (c) tailored training. One concern for partnership formation is that industry may be only interested in “quick fixes” to problems and try to “muscle” their suppliers into coming up with solutions (Zinser & Lawrenz, 2004) that may conflict with ethical practices, as well as the mission or vision of the college.

Since moral and ethical practices are fundamental to maintaining sound partnerships, both colleges and employers must use trust and communication to ameliorate potential problems (Vaughan & Associates, 1992). Community colleges need to be aware of potential conflicts or differences between the missions of the college and that of industry. Although there are problems associated with maintaining partnerships, Zinser and Lawrenz (2004) asserted that ATE programs had overcome many of the barriers that frustrate partnerships, such as community colleges being slow to change and being dual-focused on learner needs and business and industry expectations. Building a more "responsive" community college to business and industry's needs may assist in minimizing some of the obstacles associated with building partnerships.

Community college responsiveness refers to the initiatives taken to identify the workforce needs of its community, as well as making a commitment to support and sustain training programs. With the responsibilities of planning workforce development, community colleges must have a strategic plan that identifies and analyzes specific needs of the workforce (Warford & Flynn, 2000). Successful partnerships between business and industry and a college have been characterized as having the ability to determine the needs of a company and to design and deliver training to meet those needs (York, 1995). The U.S. Department of Education, Office of Vocational and Adult Education (Harmon & MacAllum, 2003) analyzed several publications in "Documented Characteristics of Labor Market-Responsive Community Colleges and a Review of Supporting Literature." The report asserted that most community colleges have evolved from their traditional roles to include mid- and high-level workforce training, and colleges that accept this new mission tend to be more "responsive" to the workforce development needs of their community. The researchers concluded that market-responsive colleges should: (a) Have leadership committed to a market-responsive mission, (b) have the ability to rapidly develop training curricula, (c) develop effective partnerships, and (d) have close ties to their local communities. Caution should be exercised in generalizing their findings in that some colleges lacking these particular attributes may still be responsive to labor market needs.

Referring to community colleges, a report by ChemTechLinks (ACS, 2006b) stated, “It is essential to participate in a healthy alliance with industry and other community partners to maintain a successful technician education program” (p. 4). The current study investigated: (a) The extent to which CBTT program sustainability is dependent upon a partnership with business and industry, and (b) what interrelationships exist among CBTT program sustainability and community colleges’ market-responsiveness, collaboration with business and industry, and cooperative curriculum development.

To summarize, community colleges must recognize that building partnerships depends upon the responsiveness to workforce needs, establishing trusted relationships, and continued collaboration and curriculum development with business and industry. The current study investigated ethical and administrative style differences between the college and business and industry. Ethical differences are considered to be the variations in moral decision-making and administrative style differences are variations in managerial and directional support for training programs. For the purpose of this study a responsive college is defined as a college’s reaction to industry’s training needs.

Leadership and the Administration of Partnerships

A college's responsiveness and development of partnerships are usually dependent upon effective leadership in getting the stakeholders together and facilitating positive outcomes. The purpose of this subsection is to describe the role of leadership in administering partnerships. A feature of a successful partnership not only in the initial stages, but throughout its life, is strong leadership. The current study explored leadership as an important ingredient in promoting and maintaining partnerships and CBTT program sustainability. A description of the characteristics of effective leadership is followed by a discussion of how college presidents or principal advocates may assume central roles in partnership-building.

Farmer and Watba (2006) suggested that community college leaders must embrace change in professional technical programs in order to keep up with each community's changing and varying levels of need. Effective leaders support their institutions by being consistent with the central mission and helping to build and sustain partnerships with internal and external constituencies (Zmetana, n.d.).

A key ingredient in maintaining both internal and external partnerships is "trust" (Sundberg, 2002). A prevailing sense of trust among all members of partnerships involving community colleges and business and industry is very important. It is vital because trust is not a one-way street, and partners must be willing to share important strategic information to strengthen relationships. Building trust is a chief attribute of leaders involved in partnerships. Leaders who are trusted make themselves and their positions well-known (Bennis & Nanus, 2005) and make it possible to focus on projects rather than positions (Kisner, Mazza, & Liggett, 1997).

It cannot be overlooked that trust will always be a contributing factor in establishing lasting partnerships between community colleges, the community, and business and industry.

Trusted leaders may emerge from college administration, faculty, or business and industry management (Youngs, 2007). Often, a committed, focused, and trusted individual emerges who greatly enhances partnerships and a program's ability to succeed-- a "champion." Champions are leaders who are strategically placed within organizations to advocate effectively for the program and assume the primary role in building and maintaining strong partnerships. A champion requires consistent support, based on trust, from college and business and industry leaders. In order to address the concept of a champion, the current study asked participants about the presence of this individual with respect to program sustainability.

A champion may come from a variety of positions, including the college president who may be well positioned to promote strong relationships between education and business and industry. The current study investigated the role the community college president plays in the strengthening of partnerships as a factor related to CBTT program sustainability. A report published by the Center for Occupational Research and Development (Brand, 1997), for which 18 community college presidents were interviewed, maintained that it is critical to be committed to economic development as part of a college's mission and to the development of new partnerships with industry. According to Brand, the college presidents regarded the success of their Advanced Technology Centers (ATC) as a major source of the success of their colleges. Even though each president in this study was involved in Advanced

Technological Education (ATE) programs at their college, they had minimal contact with the day-to-day operation of the programs. Nevertheless, Brand found that, although presidents were not versant in all details of the training programs, they had a good working knowledge of the employers' needs and what their colleges were doing to provide assistance.

The involvement of the college president may provide additional strength to partnerships and enhance program sustainability. Brand (1997) maintained that presidents felt they were often the only ones who interface with prospective partners. The current research asked faculty and administrators directly involved with CBTT programs about the role their college president played in relation to partnership building and sustainability. The involvement of the college president may provide additional strength to the partnership which, in turn, may enhance program sustainability. Through cooperation and college leadership that is supportive of true partnerships, it has been found that it is easier to convince industry members of the value of their community college CBTT program (Good, Killian, Marine, Neils & Singer, 2006).

In summary, leadership that builds trust among all members of partnerships while being consistent to the college's central mission is a necessary component of program sustainability. The presence of "champions," which may include the college presidents, is essential to continued success of CBTT programs. The current study defined the promotion of partnerships by administrators as the influence and activity in the development of partnerships with business and industry. In addition, the current study investigated the involvement of the college president in partnerships in providing support by strengthening the effectiveness of partnerships with business and industry.

Collaboration in Partnerships

This subsection examines how collaboration between community colleges and industry has influenced partnerships. The nature of partnerships in professional technical training programs is broad in design, purpose, implementation, and levels of collaboration. Collaboration through teamwork and cooperation includes pooling financial support, joint curriculum development, and sharing resources.

Business and industry may need to work with a college's traditional method of offering instruction. Jacobs (2001) indicated that business leaders sometimes do not trust that traditional faculty-developed curriculum will meet their needs. One way for business and industry to deal with a college's traditional method is through agreements in which a joint college-employer group modifies program design, serves as a vehicle to review key decisions and operations, and monitors program results (Gruber, 2000). Having greater input by business and industry may assist in minimizing distrust and improve the process of curriculum design. Furthermore this collaboration is essential given that colleges, with both internal and external constituencies, can often be seen as bureaucratic and slow in making policy decisions (Sundberg, 2002).

Sustainability of a technical training program at an Illinois community college was supported through a cooperative effort with business that involved pooling financial support, joint curriculum development, and the sharing of land, equipment, materials, and maintenance (Erwin, 2005). The success of this program was attributed to having adequate resources and developing a trusting collaboration between partners. Another contribution to this program's success was that the college and company also offered eight weeks of on-campus instruction and another eight weeks of paid internship at one of the company's sites.

In summary, although collaboration between community colleges and business and industry may experience challenges through different education and training philosophies, it is an essential ingredient in CBTT program sustainability. For the current study, differences in educational training philosophies are defined as the variation in the approach to education and training between the college and business and industry. The current research investigated the collaboration (i.e., funding, curricula input, equipment, experiential learning, and other resources) with business and industry as it related to partnerships and the sustainability of CBTT programs. The current study defined cooperative curriculum development as the cooperation between the college and employers in developing CBTT program curriculum.

Industrial Experiential Learning

The purpose of this subsection is to explore experiential learning, including internships, in professional technical training programs. Experiential learning can be a strong asset to professional technical training programs because it allows students to: (a) Gain exposure to a particular career field; (b) learn about their likes, dislikes, interests, and values; (c) build their skills and résumé; (d) expand a network of contacts; and (e) develop insight into what skills and abilities employers require.

Schmidt (1998) compared job satisfaction levels of students from a traditional dual vocational training program (TVP) with students from a non-company based program (NCP). Participants in both programs received the same instruction in the theoretical aspects of their trade, but the TVP students worked part-time at a company while the NCP students remained on campus in a simulated company environment. Overall job satisfaction levels were similar, however the TVP program graduates had a higher degree of satisfaction when employed in training-related fields. The author suggested this may be because students were able to make industry connections while training at the company. Although the study was done in Germany, Schmidt contended that the two programs could provide useful models for professional technical training in the United States. While agreeing that the study is valid, research relating to different training methods needs to be done in this country to verify any generalization of results applicable to CBTT programs. Although chemistry-based technology education is important in the global economy of many countries, the current study investigated training programs solely in the United States.

Another type of experiential learning is an internship, in which students are given the opportunity for mutually beneficial supervised training at a business or industry. Once an internship is established, its effectiveness must be evaluated from a variety of educational outcomes, including job satisfaction. Interestingly, a report from the ChemTechLinks Conference of 2004 indicated that many CBTT programs fail to offer sufficient internship opportunities (ACS, 2006b). Participants in the conference agreed that industrial experience can increase retention rates and help students develop the range of skills they need to succeed in the workplace. However, the ChemTechLinks survey of CBTT programs indicated that internships constituted part of the degree requirements in only 59% of the programs and only 22% of these programs had agreements with local industry (ACS, 2006b).

In summary, the availability of experiential learning to CBTT students provided them with the opportunity to build skills and interact with prospective employers; experiences that contributed to successful graduates as well as the programs. In the current study, experiential learning is considered to be multi-venue training or internship opportunities for students. The presence of experiential learning using multiple venues, including internships, was a variable which was analyzed in the current study as it relates to partnerships and sustainability of CBTT programs.

Summary

This section provided an account of how business and industry and community colleges have reached their current roles in partnerships involving professional technical training. The role of advisement or collaboration of business and industry in partnerships was examined. The literature reviewed in this subsection identified several characteristics of partnerships, including the role of business and industry, the role of the community college, the importance of leadership, collaboration, and experiential learning opportunities, see Figure 3. In addition, these characteristics assisted in formulating an operational definition of partnerships. For the purpose of the current study, partnerships were defined as the cooperative efforts or agreements between community colleges and business and industry to pool resources for mutually acceptable purposes in CBTT programs. The subsections within this section described the various characteristics of partnerships. First, the importance of college responsiveness to industry's needs was shown to be important in establishing and maintaining partnerships. This responsiveness included having a strategic plan and market-responsive mission, flexible scheduling and curricula, creative funding, tailored training, and committed leadership. Second, the qualities of program leaders, including presidents or champions, were found to be centered on building trust among partners. Third, various aspects of collaboration were discussed, such as joint curriculum development and sharing resources in the context of how they contribute to strengthening partnerships. Finally, experiential training opportunities (i.e., multi-venue training and internships) were described in terms of how they can benefit partnerships and professional technical training programs. Differences in educational philosophy and organizational procedures of community colleges and business and industry partnerships were presented as potential obstacles to program sustainability. The partnership factors presented above were investigated in the current study in relation to CBTT program sustainability.

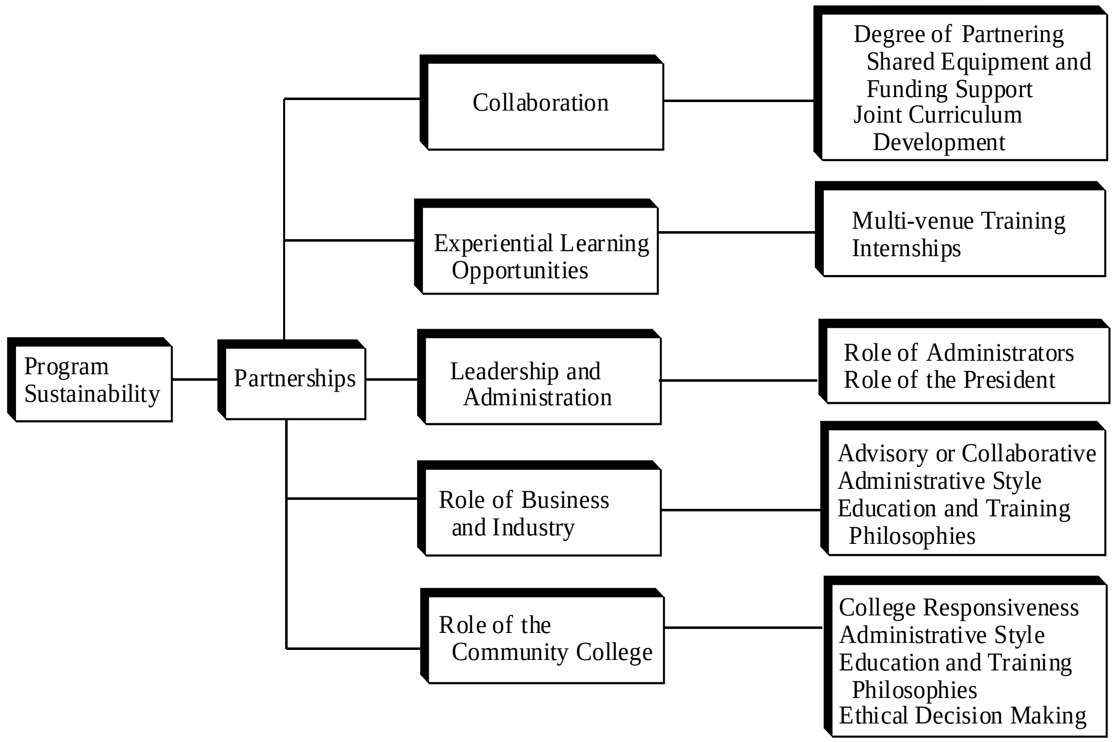

Figure 3: Partnerships and associated sub-factors related to sustainability of CBTT programs.

Employer and Student Educational Goals

While partnerships may provide sustenance to professional technical training programs, there are other factors important to each of the stakeholders, such as educational goals, that may be significant to sustainability. The purpose of this subsection is to review the factors in the literature that apply to CBTT program educational goals from the perspectives of employers and students. For the current study, educational goals refer to the attainment of employability skills, retention and completion rates, and opportunities for further education.

Employability Skills Education

The purpose of this subsection is to discuss the chemistry-based technician employability skills desired by business and industry. Employability skills include all specific job competencies necessary for job performance. Although industry has not indicated a preference in hiring certified graduates (ACS, 2006b), the current study evaluated program usage of job skill standards developed by regional industries, state labor boards, or professional organizations as essential components associated with CBTT program sustainability. In addition, this study explored the relationship of program sustainability to the use of guidelines established by the ACS's ChemTechLinks' Skill Standards.

Employers are not only interested in specific job training and skill development; they also want their employees to be proficient in the soft skills (SCANS, 1991; UNESCO, 2002). Soft skills are the elements of employability skills that are sought-after characteristics and behaviors that enhance and prepare students for aspects of their future careers, such as responsibility, sociability, honesty, contributing as a team-member, and working with cultural diversity. For several years, those involved with professional technical training have been clamoring for soft skills to be incorporated into the curricula (ACS, 2006b; Grubb, 1999b; UNESCO, 2002).

To be successful, professional technical programs must meet industry's employee needs. Currently, education and business leaders are recommending that academia work with business leaders to incorporate additional skills, such as effective communication, problem solving, and troubleshooting into the curricula of programs (Drumm, et al., 2006). The UNESCO report (2002) went beyond general academic, science, and technology subjects in recommending that professional technical students should also be versed in computer literacy, information and communication technology, and environmental studies. Other learning experiences and proficiencies employers desire in training programs include résumé writing, electronic portfolios, interviewing, peer review, work ethics, written laboratory reports (as individuals and as team members), and capstone projects (ACS, 2006b).

If professional technical training is not providing qualified workers for business and industry, it could have a detrimental effect on a program's sustainability in that employers will look elsewhere for their employees. Gruber (2000) noted that a challenging issue for community colleges in workforce training is teaching the curriculum in a way that not only engages and benefits trainees but also fits the prevailing company culture. Dissimilarities often exist in the curricula of professional technical and academic students signifying that community colleges are still primarily organized on an academic model (Bailey, Alfonso, Scott, & Leinbach, 2004). A curriculum model that emphasizes academic values and processes prevails in community colleges despite the increasing importance of professional technical education. Academic education in community colleges tends to focus on preparing students to obtain a bachelor's degree and assumes the soft skills will be assimilated along the way. Professional technical training tends to focus on specialized job skills. Continued emphasis on an academic model in professional technical training may result in colleges being less efficient in developing integrated employability skills for both students and employers. Integrating academic and professional technical education helps develop more well-rounded students who will manifest self-motivation, adaptability, and interpersonal skills on the job. If comprehensive professional technical education and training programs are developed adequately, they need to assist students in expanding competencies beyond specific job skills (UNESCO, 2002).

The challenges in the preparation of students for careers in chemistry-based technology are many and varied. Chemistry-based technicians are not only required to have the necessary chemically technical job skills, but they must also interact with a variety of coworkers and should possess good writing and oral communication skills. Although an ACS report (2006b) concluded that most CBTT programs included some oral presentations and technical report writing, the report did not indicate how often these skills were incorporated or assessed. In addition, chemistry-based technicians must not only be able to work independently, they must be able to work effectively as team members and have good problem solving abilities.

Many students enrolling in CBTT programs come directly from industry (ACS, 2006b) and if industry does not feel a program is providing a curriculum that adequately provides employability skills, they may lose interest in supporting the CBTT program. Furthermore, if community colleges do not have a strong understanding of industry's needs, students participating in CBTT programs may lack the necessary employability skills upon program completion, thus impacting retention rates and program sustainability. "Students entering technical education programs want assurances that they will find jobs upon graduation" (ACS, 2006b, p. 7). If CBTT program graduates cannot find jobs, then future students will be less likely to enroll and current students may not complete program requirements.

In summary, it is important that stakeholders recognize the differences between the goals of academic and professional technical training and how they may be integrated to improve program effectiveness. Additionally, business and industry have indicated a need for soft skills to be blended into the curriculum of professional technical training. Although specific job skills in chemistry-based technology cannot be ignored, communication skills, teamwork, and problem solving were also important. As contributing factors toward employer and student educational goals, the current study investigated cooperation between industry and academia in both curriculum development and employability skills. Employability skills are defined as broad-based integrated job skills and education to include adaptability, teamwork, problem-solving, and effective communication. Furthermore, the current study investigated the use of job skill standards, which are defined as specific job skill standards developed by leaders of regional business and industry, state labor boards, or the ACS. Technical training programs need to address not only employer's needs, but also the needs of students that enroll in these programs. Students have educational goals that should be integrated with those of business and industry.

Student Goal Attainment

The purpose of this subsection is to discuss the factors influencing the decisions professional technical students make while working toward degrees or certificates or attaining job skills. According to Jacobs (2001), the heterogeneity of enrollment patterns among community college students is a major challenge to the attainment of goals in postsecondary professional technical programs. Programs enroll students of diverse backgrounds, different life experiences, broad ranges of educational goals, and a variety of ambitions. This diversity makes it difficult to create sequential core curricula to assist students in reaching their goals (Bragg, 2001).

There are several reasons why students choose a particular kind of postsecondary education, including sub-baccalaureate degrees, career employment certification, or training for job promotion. Additionally, returning adults may have little interest in structured programs, instead seeking the acquisition of specific skills. Professional technical programs were often characterized as being primarily designed to train individuals for specific jobs, and students in programs may aspire to goals that do not necessitate earning degrees (Lohman & Dingerson, 2005). Lohman and Dingerson pointed out that there are a variety of factors that contribute to attrition in professional technical programs. Participants often enroll in programs for reasons other than a certificate of completion, and once a goal is attained there is no reason to remain. Some students may already have a degree, enrolling in these programs for the sole purpose of simply increasing career opportunities or learning a specific job skill.

In a national study of pre-baccalaureate education, Grubb (2002) found that there were substantial economic benefits to individuals who complete programs and find employment related to their fields of study. According to Jacobs and Voorhees (2006), professional technical programs often did not emphasize completions of credentials as a necessary prerequisite for job entry, and that community colleges could do more to promote the value of program completion. The authors also stated that employers do not always wait for students to finish their programs before offering full-time employment, in effect “eating their young” (p. 137). Jacobs and Voorhees concluded that the phenomenon of students departing programs prior to completion may also indicate a mismatch between program curricula and what is required for successful employment.

Bailey, Alfonso, Scott, and Leinbach (2004) studied degree completion rates and persistence of community college professional technical students with other postsecondary students. The authors found that professional technical students were less likely to complete their educational goals than their academic counterparts. Some of these students indicated they could achieve their personal educational goals (i.e., learning a specific skill) without completing a degree or certificate.

Willet and Luan (2000) analyzed differences between community college students who completed professional technical programs and those who did not. The authors concluded that students who are focused on obtaining a degree or certificate in a particular field were more likely to complete programs. However, between the two groups there were no significant differences in employment status or satisfaction with the program. Some students that left the programs indicated they had completed enough of their education to satisfy their personal enrichment goals (i.e., job enhancement). Other students indicated reasons for leaving their programs were time constraints, finances, job changes, and personal reasons. The problem of student dropouts may be alleviated by the college providing flexible scheduling, scholarships or financial aid, and industry contributing by not hiring students prior to the completion of the program. The hiring of students by business and industry prior to the obtainment of a degree or certificate was investigated in the current study as a possible factor contributing to program sustainability. In addition, the study analyzed the relationship between the numbers of students obtaining a degree or certificate and CBTT program sustainability.

Community colleges sometimes base the evaluation of programs on the number of students obtaining degrees or certificates, as opposed to the achievement of personal goals. Because student goals are often met prior to obtaining a degree or certificate, retention and completion statistics do not provide definitive evidence regarding educational achievement in professional technical programs. Lohman and Dingerson (2005) recommended that assessments should not be simply based on the number who complete a program but on the number of students whose needs and goals are met. Grubb (2002) pointed out that advocates of community colleges often claim that students who appear to be dropouts actually only seek to complete enough coursework for purposes of advancement in their jobs. In addition, the ACS (2006b) acknowledged that some students have difficulty making the connection between completing a CBTT program and obtaining a job in industry.

In summary, students leave CBTT programs prior to completion for a variety of reasons, and these factors may influence program sustainability. The current study investigated interrelationships among student educational goals in the form of the number of students completing the CBTT program, obtaining jobs prior to completing the program, and job placement in business and industry. Job placement is defined in the current study as students obtaining employment in a chemistry-based field. The current study also defined program completions as a student’s conclusion of a CBTT program with a degree or certificate. In addition, business hiring practices of non-graduates of programs are considered to be the offer of employment to students prior to the completion of the program. Another student educational goal this study evaluated, with respect to program sustainability, was transferability of course credits to four-year institutions.

Program Transferability

The literature reviewed in this subsection addressed continuing educational opportunities for students enrolled in professional technical programs. According to Bragg (2001), matriculation from professional technical programs in community colleges to four-year institutions is increasingly important to advance students' careers. Transfer is not generally recognized as an outcome when assessing the attainment of goals in professional technical programs, but the importance of transfer to lifelong learning and career preparation for all college students is gaining in popularity (Bragg, 2001).

There are, however, difficulties that exist in the transfer process. Many professional technical training courses are not recognized by four-year institutions for transferable credits. Wilhelms (2001) indicated that programs with increased complexity could be connected in "ladders" of opportunity. These ladders may begin with a student enrolling in one or two job training courses and subsequently moving into a related associate or bachelor degree program. This suggested a need for the community colleges to play a crucial role as "bridges" between the short-term training and the mainstream of the education system. Bragg (2001) asserted that more students are electing to enroll in two-year professional technical programs before transferring to a four-year college to obtain applied baccalaureate degrees. These transfer programs generally include substantial academic course work and more advanced technical training courses. Many transfer students do not necessarily complete a program of study when they transfer to a four-year institution and records often show them as non-completers of programs in two-year colleges (Bailey, Jenkins, & Leinbach, 2005). Bailey, Jenkins, and Leinbach asserted that a program's effectiveness is often measured in terms of the number of students that obtain a degree or certificate, and transfer students do not always receive a diploma prior to transferring to a four year institution. Thus program effectiveness may be misinterpreted when students transfer and do not complete their program through graduation.

Incorporating transfer as a feature of professional technical education provides a variety of opportunities for students as well as challenges for postsecondary vocational education (Bragg, 1997; Grubb 1997). The ACS (2006b) advised community colleges to develop articulation agreements with four year institutions that will allow students who complete their CBTT programs to transfer their coursework. Transfer options would allow students to continue their education and complete higher degrees. The options for students and the choices they make during and after training in community colleges may have an influence on the success and future sustainability of CBTT programs. For example, the opportunity for students to transfer credits to a four-year college could influence their motivation to enroll in as well as complete the program. The seamless transfer of CBTT program course credits to regional four-year colleges was analyzed in the current study as a possible variable associated with sustainability. This study also examined the relationships of program completion and job attainment to the sustainability of CBTT programs.

In summary, the provision of transfer opportunities for students in professional technical programs requires high-quality articulation agreements between colleges. The transferability of credits to four-year institutions may be important to student recruitment and retention, the advancement of careers, as well as the sustainability of CBTT programs. For the current study, program credit transferability is defined as the potential for coursework and credit to be transferred to a four-year institution.

Summary

The literature reviewed in this subsection provided insight into some of the educational goals of employers and students that may influence the sustainability of CBTT programs. This insight assisted in the development of the current study's operational definition for "employer and student educational goals" which was defined as common educational objectives of employers and students that are related to employability skills and job attainment. The literature also indicated a need for an integrated program curriculum to train employees in employability skills, including soft skills, learning experiences, and proficiencies. The acquisition of specific skills, job attainment, and opportunities for transfer to four-year institutions was found to be related to student program completion rates. However, evaluations of completion rates were often misleading because of the variety of reasons students leave programs before completing requirements for a degree or certificate.

In the current study, employer and student educational goals, including employability skills, completion rates, and program transferability were investigated in relation to program sustainability. These factors and their associated sub-factors were analyzed in the current study in order to determine interrelationships associated with the sustainability of CBTT programs. See Figure 4 for a summary of the employer and student goals factors and sub-factors.

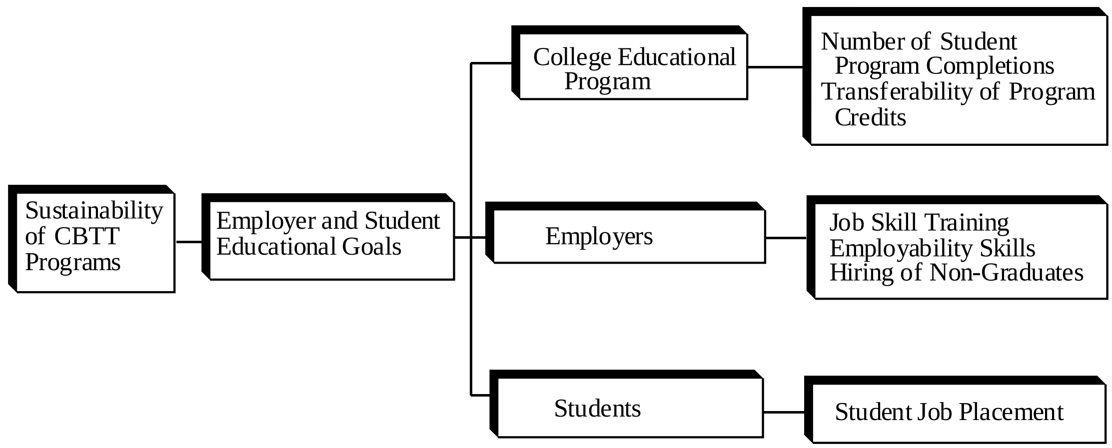

Figure 4: Employer and student educational goals and related sub-factors associated with sustainability of CBTT programs.

Faculty and Their Resources

The purpose of this subsection is to present characteristics of professional technical faculty and the resources that may contribute to the sustainability of CBTT programs. The way instructors teach is influenced by their students, education, preparation for teaching, the institutional culture, incentives provided by their college, and resources at their disposal (Grubb, et al., 1999). The development of professional technical training programs, including a new associate's degree, may compel community colleges to reassess their faculty support policies, because new programs often require assessing and marshalling resources under new priorities (Zinser & Lawrenz, 2004). This implies that in the process of undertaking updates, redesign, and evaluation of programs, policies regarding faculty resources need to be considered.

Institutions, such as community colleges, where teaching is a collective institutional responsibility, should devote their resources primarily to the quality of instruction (Grubb, et al., 1999). Unfortunately, Grubb, et al. also indicated that colleges often fail to use their institutional resources effectively to enhance the quality of instruction. The following section includes a discussion of faculty positions, relevant and current curricula, professional development, laboratories and equipment, funding, and institutional support associated with CBTT programs.

Faculty Positions

The purpose of this subsection is to discuss characteristics of full-time and part-time faculty in terms of their teaching abilities, workload issues, and factors affecting instructor retention. Differing opinions concerning the use of part-timers are presented, along with the effects of excessive faculty workloads, and factors related to instructor job stress and burnout.

A UNESCO (2002) report concerning technical training in the 21st century asserted that qualified instructors are the fundamental key to providing quality education for individuals to reach high standards in academic and professional technical competencies. According to Krueger (2005), instructors are as important to the success of training programs as they are to traditional academic programs. However, like other disciplines many instructors of professional technical programs are not full-time tenured faculty and the use of adjunct faculty is a relevant topic of discussion in community college education.

Part-time faculty. An issue associated with instructional effectiveness is the use of part-time faculty in professional technical training programs. Part-timers with recent experience in business or industry were used to bring specialized instruction to the community college (Wallin, 2004). However, fiscal pressures have caused colleges to use part-timers (with relatively low compensation and no benefits) to teach even the core subjects (Grubb, et al., 1999). The numbers of part-time faculty in all disciplines of post-secondary education increased about 80% from 1981 to 1999, up to about two thirds of all community college faculty (Wallin, 2004). Lawrenz and Keiser (2001) observed very small numbers of regular faculty and large numbers of part-time faculty during their visitations to ATE centers. The ChemTechLinks (ACS, 2006b) survey of CBTT programs indicated that the extent to which programs relied on part-time faculty varied, with only seven of the responding programs using no part-time chemical laboratory faculty.

There are conflicting opinions as to whether using significant numbers of part-time faculty is a positive development in community college education. According to Lankard (1993), the use of part-time faculty has two main advantages: cost savings and staff flexibility. The use of part-time faculty is attractive to colleges, because they may be providing recently acquired knowledge of business and industry techniques. On the other hand, sustainability of programs may be negatively affected if there are financial cuts, because part-timers with current industry experience are most likely to go first (Lawrenz & Keiser, 2001). In addition, the quality of teaching by part-time faculty is also in question. Banachowski (1997) pointed out that some studies indicated that part-time instructors were less effective than full-time instructors, while other studies (i.e. Gappa & Leslie, 1993; Roueche, Roueche, & Milleron, 1995) concluded there were no differences in the type or quality of instruction. Part-timers may have multiple commitments that impede their ability to collaborate with other instructors and take time away from the responsibilities required to teach effectively. Grubb, et al. (1999) presented the provocative argument that full- and part-time instructors are considered comparable in teaching abilities, because institutional conditions that support good teaching are missing in most community colleges, resulting in a leveling effect between them.

Investigation of the recruitment and retention of part-time faculty, in addition to the quality of education provided by these instructors, was explored in the current study in relation to CBTT program sustainability. However, the use of part-time faculty is not the only faculty issue associated with CBTT programs; excessive faculty workloads may also affect program sustainability.

Faculty workload. This section discusses the issue of faculty workloads. Some prominent organizations have taken a strong interest in professional technical education and training throughout the world and expressed concerns about this issue.

UNESCO (2002) recommended that technical training instructors should have reasonable teaching loads along with the means to improve their androgogy and subject matter competency. In contrast to many academic instructors, professional technical instructors must master a wide range of teaching methods, stay current in their professional areas, and balance the demands of students, the institution, and industry. Unfortunately, the empirical literature on the special conditions of professional technical instructors in community colleges is sparse (Grubb, et al., 1999), indicating a need for continued research on workload issues.

The ChemTechLinks report stressed that CBTT faculty often have excessive workloads and must deal with less institutional support than academic departments (ACS, 2006b). Community college instructors generally have teaching loads of 15 hours per week, which is about 50% more than their four-year counterparts. In addition, laboratory and lecture hours generally are not equivalent in workload credit. This inequality often requires science and professional technical instructors to teach additional classes. The ChemTechLinks (ACS, 2006b) survey indicated that about 60% of the community college instructors of chemistry-based laboratory technology programs had teaching loads of greater than 16 contact hours with 11% greater than 25 contact hours per week. These hours do not include meetings, advising, office hours, preparation time, and grading. Additionally, administrators often expect CBTT faculty to teach full loads, as well as recruit students, update personal knowledge to maintain program currency, and develop partnerships with industry (ACS, 2006b).

Excessive instructor workloads were examined in the current study as a possible factor related to the sustainability of CBTT programs. Excessive faculty workloads are defined in the current study as abnormally high teaching assignments and additional duties or responsibilities. Excessive workloads for faculty can lead to job dissatisfaction, job burnout, and poor quality of instruction, which in turn can lead to problems associated with instructor retention and CBTT program sustainability.

Instructor retention. This section examines issues related to instructor retention including job stress. These issues may affect the recruitment and retention of instructors in technical and community colleges across the nation. So that resources can be directed effectively, it is important to study the factors that enable colleges to retain instructors, especially in specialized fields such as chemistry-based technology.

In a quantitative study of factors that influenced turnover and retention of technical training teachers, Ruhland (2001) identified several work environment and external factors related to why instructors left the teaching profession. The work environment factors identified included lack of job security, job advancement, support from the administration or department, teacher preparation, a lack of resources, and job related stress. External factors identified included salaries, commitments outside of teaching, and licensure requirements. Ruhland suggested the need for further research to identify other factors associated with instructor retention. Neither the PACTS survey (Stander, et al., 2000) nor the Critical Issues report (ACS, 2006b) addressed factors related to the retention of instructors, indicating a need for further research in this area.

The current study explored some of the variables associated with instructor retention. This included such aspects as administrative and emotional support, faculty workload, and professional development opportunities as they relate to CBTT program sustainability.

Summary. Whether full-time or part-time, professional technical faculty nourish the learning environment of students while playing multi-faceted roles in CBTT programs. Instructors must be knowledgeable and able to teach effectively in classrooms and laboratories. All instructors are valued for their expertise and teaching skills, but part-time faculty are regularly faced with different challenges than regular faculty. The quality of instruction and the use of part-time faculty is defined in the current study as the effect of the use of part-time instructors on the quality of education. Faculty workloads are frequently excessive and can impair effective instruction. Workload issues, job stress, inadequate resources, and lack of institutional support all contribute to the problem of instructor retention. The recruitment and retention of faculty is defined as obtaining and retaining CBTT program faculty. Without qualified and dedicated instructors, the sustainability of CBTT programs is certainly threatened.

Relevant and Current Curricula

The purpose of this subsection is to provide background with respect to presenting current and relevant material to students in professional technical training programs. The importance of using real-life examples or including on-the-job training in the curricula is discussed along with the impact on training effectiveness.

There is an increasing need for colleges to update their curriculum so that it addresses the latest technologies and industry practices (Frenzel, 2003; Zinser, 2003). Professional technical education is a prime example of a field in which it is essential to present current, relevant, and technologically sound subject matter. Instructors in CBTT programs are confronted with the ever-changing needs of contemporary society, and many modify their curricula regularly. The ChemTechLinks report (ACS, 2006b) indicated that 52% of CBTT programs revised their curriculum every year; however the extent of these revisions was not investigated in the research. Regular curriculum modification compels instructors to stay current with not only the subject matter but also the needs of business and industry.

Vars and Beane (2000) suggested that technology-based education should also include solving authentic workplace problems using multidisciplinary knowledge. In an evaluation of a community college technical program, company managers observed that very few instructors use business case studies or assignments and only about half have had a company review a course outline (Zinser, 2003). College administrators generally agree that training programs are most effective when they connect in a concrete way with the workplace, with instructors incorporating real-life work practices into classroom learning (Gruber, 2000). To use and develop workplace problems or case studies, professional technical instructors must have additional professional development opportunities available to them. Such opportunities include cooperative curriculum development with business and industry providing workplace examples, direction, or faculty internships.

The Gulf Coast Process Technology Alliance (GCPTA), which includes 16 colleges, 22 industries, and other educational, business, and government partners, is highly involved in the development of course curricula with an industrial accent. Raley (2000), writing about the GCPTA, asserted that instructional materials need to be developed quickly with the use of training providers outside of education, and industry representatives should have a majority vote in the alliance. However, this opinion may not be shared by all stakeholders in partnerships because of the challenges associated with collaborative curriculum development. Designing curricula can be frustrating for members of partnerships, because industry often makes prompt decisions and acts on them quickly, whereas colleges, slowed by bureaucracy, are reluctant to change from traditional instructional methods (Spangler, 2002). The current study investigated the relationship of CBTT program sustainability and the extent of industry collaboration in curriculum development.

Although instructors may be able to respond to employer demands and transmit them through effective instructional delivery, it can be a challenging endeavor. Some colleges organize advisory committees to provide a college-industry linkage for curriculum development. However these committees were often found to be ineffective and exist more for public relations purposes only (Grubb, et al., 1999). Establishing links between industry and the college frequently resulted in instructors having to work against the culture of American firms, which have been more reluctant to support training than their competitors in other countries, especially Germany and Japan. Jacobs (2001) asserted that many employers do not trust that traditional faculty-developed curriculum will meet their needs. Jacobs also suggested that postsecondary professional technical education is continually challenged to sort and re-sort curricula based on the mastery of skills that ensures student employment. Students' mastery of skills required for employment further supports the need for collaboration with business and industry in curriculum development.

Not only does professional technical instruction face challenges in curriculum development, it must be constantly aware of who it serves. Professional technical instruction differs from academic instruction in part because it serves two masters: students and employers (Grubb, et al., 1999). UNESCO (2002) stressed that technical education for students should provide the foundation for productive and satisfying careers that: (a) Lead to the acquisition of broad knowledge and generic skills applicable to a number of occupations within a given field; (b) offer both a thorough and specialized preparation for initial employment; and (c) provide the background of knowledge, skills, and attitudes for continuing education at any point in an individual's working life. In order to address the needs of both employers and students, assessment of a program should not only evaluate courses associated with industrial skill standards but also their applicability to employability skills and transferability to a four-year institution. This provides further support for the current study's examination of CBTT program sustainability, including soft skill curricula, use of job skill standards, and transferability.

Regarding learning processes, UNESCO (2002) suggested that continuous evaluation should be undertaken with the participation of instructors, supervisors, students, and representatives from occupational fields. The ChemTechLinks survey reported the existence of sufficient, but not overwhelming, support for programs in terms of curriculum review (ACS, 2006b).

In summary, program curricula development should be an on-going process, with input from both college and industry personnel. The process should include review of material to ensure its currency and relevancy as well as regular modifications. The current study did not address the frequency of program review, but rather the professional development opportunities provided by the college for faculty in response to curriculum changes associated with program reviews. In order to compensate for the changing training needs of students and their employers, faculty must have professional opportunities to hone their teaching skills and update subject matter competencies.

Professional Development

The purpose of this subsection is to discuss the importance of upgrading subject matter competency and classroom performance of professional technical instructors. The subsection will also present the opportunities provided by various institutions and organizations and the content of some staff development programs.

Professional development is a resource that seeks to benefit all instructors in the professional technical field. Professional development opportunities for faculty include seminars, short courses, summer institutes, and industry-based experience, which are intended to update subject matter competency, improve classroom performance, or provide an experiential industrial background (Grubb, et al., 1999; Maurer, 2000). Certification demands, teacher shortages, new technologies, and relevant curricula indicated the need for professional development for instructors (Brown, 2000). Lawrenz and Keiser (2001) pointed out that professional development for faculty provides the specific knowledge and skills necessary to sustain professional technical programs and that faculty should be afforded development opportunities through institutional support. Maurer (2000) further asserted that only through ongoing education and development can instructors become more effective professionals.

Professional development often focuses on upgrading course content, but other aspects of education and training are also important (Grubb, et al., 1999). Professional technical instructors have indicated that they really have two professions: technology specialists and educators. However, professional technical instructors are more prone to undertake professional development in activities that directly relate to their specialty rather than in teaching methodology. Grubb, et al. suggested colleges with effective institutional mechanisms recognize that professional technical instructors should address the needs of issues other than their teaching specialties, and should be encouraged, if not directed, to examine their roles as educators through professional development opportunities. Unfortunately, as Grubb, et al. described, many college-directed staff development opportunities are not focused on teaching or, if they were applicable to an instructor's needs, presented as short-term activities that are often unsuccessful. Instructors need on-going programs that will allow exchanges in ideas that will be assimilated into effective teaching strategies. In addition, staff development was seldom directed to beginning or part-time instructors and failed to provide the personal and class-specific attention that might benefit all faculty.

The ATE program supports projects that provide instructors with opportunities for continued professional growth in areas that directly impact technical education (Mahoney & Barnett, 2000). ATE is particularly interested in: (a) assessing future trends of technicians, (b) assessing components of technician programs that work, and (c) evaluating educational strategies that have proven to be most effective. Professional development for chemistry-based technology faculty has been identified as an important instructor resource (ACS, 2006b). As an indication of their interest in professional development, the ACS Division of Chemical Education continues to offer annual awards to full-time chemistry or chemistry-based technology faculty for workshops, short courses, or advanced courses in their field (ACS, 2005). In addition, the ACS's supported ChemTechLinks project offered scholarships for short courses and summer workshops that could help faculty stay current in their teaching.

Some states, including Oregon, provide funds for professional development for professional technical program instructors and administrators (Oregon Department of Education, 2006). Professional development programs may include conferences, regional partnerships, and visitations by consultants to local programs. The ChemTechLinks critical issues report (ACS, 2006b) indicated that about 80% of the institutions responding to their survey provided financial support for professional development to full-time instructors, but only one-third of the part-time faculty received such support.

In summary, professional technical instructors should serve their students as technology specialists and as educators. In order to be proficient in both roles, educators require substantial professional development opportunities, including updating subject matter competency, improving teaching methodology, industry-based experience, interaction with other CBTT instructors, and training in the use of new equipment. The current study investigated the relationship of professional development and training opportunities for all CBTT program faculty to the sustainability of CBTT programs. Professional development consists of opportunities for faculty to improve subject matter proficiency, currency, and teaching effectiveness. With the advancement of new technologies and the changing needs of business and industry, essential faculty resources such as up-to-date and safe laboratory facilities, equipment, and instrumentation are required.

Laboratory Facilities and Equipment

This subsection emphasizes the importance of having adequate, safe, and updated facilities, equipment, and instrumentation. The laboratory provides the core of technician training and should be given careful attention by the institutions sponsoring professional technical training.

Professional technical training generally has the lecture combined with a laboratory experience. In lecture, instructors provide the knowledge and related theories about the subject, while the laboratory provides the "hands-on" applications of subject material presented in lectures by using specific equipment and instrumentation. UNESCO (2002) called for particular attention to be given to the material resources required for technical education, with priorities given to immediate needs and probable future needs. UNESCO also indicated that machines and equipment in educational institutions should be geared to the needs of employers and simulate those of the workplace. In a report for the National Coalition of Advanced Technology Centers, Anderson and Kosarek (1997) recommended that technician training must be done by faculty with relevant work experience and with equipment actually used by industry. Chemistry-based technicians need to receive relevant "hands-on" training in a laboratory setting using a variety of chemicals, equipment, and current instrumentation.

Laboratories are the focal points for obtaining experience in chemistry-based technology training. The experience gained in laboratories is intended to be translated directly to industrial workplace settings. If up-to-date and safe laboratories are not provided in CBTT programs, faculty lose an important resource related to program sustainability. The PACT survey (Stander, Schalinske, & Sarquis, 2000) indicated that chemistry-based technology instructors felt that employers valued laboratory skills more than any other subject. The survey also found that laboratory skills and instrumentation were two of the most important aspects considered by students, technicians, and faculty. Realistically, community colleges cannot use the same kind of equipment and instrumentation as industry, but they should prepare students to be able to adapt to various types of equipment and instrumentation and to future technologies (ACS, 2006b). A lack of adequate equipment and instrumentation limits an instructor's ability to design experiments that are related to concepts needed by students for future employment. This implies a need for the current study's investigation of adequate laboratory facilities, equipment, and instrumentation used in CBTT programs. In addition, this study researched the continued external support (outside the college) for funding, equipment, and instrumentation.

Equipment provided through partnerships has often saved professional technical programs from providing inadequate training (Grubb, et al., 1999). Oftentimes much of the burden of obtaining equipment and materials falls on instructors (ACS, 2006b; Zinser, 2003). Ironically, this means that the least powerful participants in technical training are responsible for resolving what should be an institutional problem (Grubb, et al., 1999). In a survey of chemistry-based technology programs, 52% of the respondents regarded their equipment as mostly up-to-date by industry standards, with 26% characterizing their equipment as moderately up-to-date (ACS, 2006b). The remaining percentage is disturbing, because it indicates that many programs do not have the material resources to support their programs. Inadequate preparation for a career in chemical technology that is caused by insufficient or outmoded training equipment and instrumentation could be a factor that influences the sustainability of CBTT programs.

In summary, laboratories are the central venues for professional technical training and, as such, must be geared to employers needs by providing simulated workplace experience with appropriate equipment and instrumentation. The acquisition of relatively current equipment and instrumentation is often facilitated through partnerships and sources of external funding.

Funding Resources

It is the purpose of this subsection to discuss how the quality of instruction is affected by funding for facilities, equipment, supplies, staffing, and flexible scheduling. It also includes some of the problems institutions face in obtaining and maintaining funding for their professional technical training programs.

Community colleges contribute significantly to the preparation of America's workforce with low-cost programs for students and flexibility in providing instruction as their hallmarks (Jacobs & Voorhees, 2006). However, instructors and administrators of professional technical education in community colleges frequently face a lack of adequate funding for facilities, salaries, supplies, equipment, staff development, and flexible scheduling. Grubb, et al., (1999) noted that community colleges are often funded with only English and mathematics classes in mind, where the only supplies needed are a blackboard and chalk. However, for professional technical training programs it is not that simple. There are many fiscal problems for all CBTT programs, including recurring and capital expenditures. Recurring expenses include salaries, benefits, and materials and supplies, whereas capital expenses often include expensive laboratory instrumentation and facility modifications. Capital expenses are usually funded from separate accounts where available funds are never sufficient college-wide, and professional technical programs find fierce competition in funding their programs (Grubb, et al., 1999). To help alleviate funding competition, it is desirable to have a champion with the ability to advocate for and effectively communicate the needs for CBTT programs in order to secure both internal and external sources of revenue (ACS, 2006b).

With enrollment-based funding establishing institutional priorities, many institutions do not consider CBTT programs central to their mission and hence may not adequately support their needs (ACS, 2006b). Given a lack of understanding of the chemistry-based technology profession, leveraging for resources presents difficulties within institutions. As a result, most CBTT programs receive minimal monetary support relative to other academic departments (ACS, 2006b). Evaluation of funding from both internal and external sources to provide facilities, equipment, and instrumentation for the college was investigated in the current study of CBTT program sustainability.

Program directors and instructors often rely on external grants for funding (Grubb, et al., 1999). Grants from business and industry are frequently in the form of equipment, materials, or faculty internships (ACS, 2006b; Gruber, 2000; Lawrenz & Keiser, 2001). Significant government grants include the Carl D. Perkins Vocational and Technical Education Act, Advanced Technological Education programs, and other NSF supported activities, including ChemTechLinks. One problem associated with external grants is that the programs they fund may not be institutionalized or sustained. Lawrenz and Keiser (2001) recommended that ATE projects identify and use strategies to obtain additional funding beyond the timeline of their NSF grant. The reliance on external resources for programs is understandable in a period of dwindling public funding, but it has never been a good way to support institutions. Establishing community colleges as teaching institutions requires funding for instruction that is more stable, more universally “owned” by administrators and instructors, and more central to the core purposes of colleges than external funding (Grubb, et al., 1999).

Attempting to meet the needs of employers and students, some community colleges have tried to provide a range of course offerings, days and times, and educational delivery methods. UNESCO (2002) recommended that organizers of technical education programs should consider the following flexible forms of delivery: (a) evening and weekend courses, (b) on-line courses, (c) short “refresher” courses, and (d) courses offered during working hours at the workplace. However, offering flexible scheduling of courses to meet the needs of both students and employers is dependent upon the adequate funding and resources available to faculty. For example, offering additional classes at alternative times can decrease enrollments in a particular class, require additional instructors, and there may be space issues related to classrooms and laboratories. The current study analyzed how aspects of flexible scheduling were related to the sustainability of CBTT programs.

To summarize, funding for professional technical training is often inadequate due to college enrollment-based funding practices and competition among divisions. Funding in the current study is defined as the external and internal funding for faculty positions, facilities, equipment, and instrumentation. Reliance on different forms of course delivery and external grants has not solved the problems of generating operational revenue for relatively costly training programs.

Institutional Support

Several aspects of institutional support relative to faculty resources have already been discussed. This subsection, in contrast, will focus on the role of administrators in the areas of emotional support of faculty and organizational support.

Emotional support from the college and community is necessary to provide positive workplace environments, improve morale, retain qualified instructors, prevent job stress and burnout, and improve the quality of instruction (Brewer & McMahan, 2004). In a quantitative study of industrial and technical instructors, Brewer and McMahan found that respondents perceived the lack of organizational support as more severe than any other stressor they encountered and recommended that administrators investigate how institutional support affects professional technical education. In a separate study of job satisfaction among industrial and technical educators, Brewer and McMahan-Landers (2003) recommended that administrators should seek to understand why professional technical instructors reported lower satisfaction with supervision than academic faculty. The authors also recommended that administrators interested in improving job satisfaction of instructors should direct attention toward supervisory policies that would improve morale. This issue was addressed in the current study by investigating the relationship of CBTT program sustainability to administrator contribution to instructor morale building and job satisfaction.

Grubb, et al. (1999) pointed out that professional technical instructors sometimes feel threatened, because many colleges are not committed to professional technical education. The authors asserted that faculty in professional technical training areas are frequently seen as having lower status than academic instructors.

In addition Grubb, et al. indicated that many administrators create conditions that discourage innovation and attention to teaching, because they are distant from the classroom, have funding concerns, and are hostile to changes that disrupt established routines. Finally, the authors indicated that while some administrators are knowledgeable about teaching, most are ignorant about how or what happens in classrooms. Generally speaking, administrators who have been very active in educational roles are usually better informed and insightful about teaching and the plights of instructors. An important point to make here is that the attitude of administrators regarding teaching has a profound effect on education, and administrators are obliged to create a positive educational environment that fosters teaching excellence.

In summary, this subsection pointed out the importance of emotional and moral support for instructors in professional technical training programs. Emotional support of faculty from administrators is the encouragement toward morale building and job satisfaction for program instructors. Providing positive workplace environments and improving morale can assist in the retention of qualified instructors. Characteristics of administrators that encourage innovation and attention to teaching were also discussed.

Summary

This subsection of the literature review presented factors related to faculty and their resources in CBTT programs. An assessment of the needs of faculty assists in understanding the relationship of resources to the sustainability of CBTT programs. For the purpose of this study, “faculty and their resources” was operationally defined as CBTT program instructors and the supporting instructional resources available from the college, business and industry, and/or the community. In order to provide insight into CBTT program sustainability, two types of resources important to professional technical faculty were identified: tangible and emotional. The tangible aspects include faculty positions, curriculum development, professional development opportunities, laboratory facilities and equipment, and funding. Emotional aspects include elements of institutional support, including building and sustaining morale.

Three topics regarding faculty positions were included in the review: part-time faculty, workload issues, and instructor retention. A discussion of the use of part-time faculty included the pros and cons of their participation in professional technical programs. Positive factors included cost-saving and contribution of recent knowledge. Negative factors included possible lack of job security and quality of instruction. The effects of excessive faculty workloads were addressed in the literature review in terms of adverse morale and teaching effectiveness.

Another topic addressed in this section of the literature review was curriculum development. Dual responsibilities of professional technical instructors to both students and industry provide many challenges in curriculum development. Unlike many traditional academic disciplines, professional technical instructors must be able to teach specialized and constantly changing subject matter. Furthermore, the responsibilities for collaborative curriculum development should be assumed, in varying degrees, by the college, industry, and faculty.

The literature reviewed also included the many advantages of faculty professional development programs along with the range of opportunities available.

Some programs and organizations offer substantial opportunities while others do not. Individuals involved in CBTT programs regard professional development as an important factor in their faculty's resources. As a result, the current study included this variable in its quest to determine the factors associated with CBTT program sustainability.

Appropriate funding for instructional facilities, equipment, and instrumentation was discussed as an important resource to faculty. Flexible scheduling, while advantageous, has its drawbacks in funding for personnel and support. For the current study flexible scheduling is the offering of classes at non-traditional times or at alternative venues. Research indicated that without adequate laboratories, equipment, instrumentation, or funding from internal or external sources, the sustainability of CBTT programs may be in jeopardy.

Finally, the importance of institutional support was discussed. Support from college leadership, including the presence of a "champion" plays an important role in obtaining and managing funds, promoting collaboration among stakeholders, and improving faculty morale. The current study defined a champion as a leader that effectively advocates for support of the program. The presence of a champion, the use of part-time faculty, workload, retention, professional development opportunities, materials, funding, and institutional support were included in the current study in relation to CBTT program sustainability. See Figure 5 for an illustration depicting the factors and associated sub-factors of the clustered category "Faculty and Their Resources".

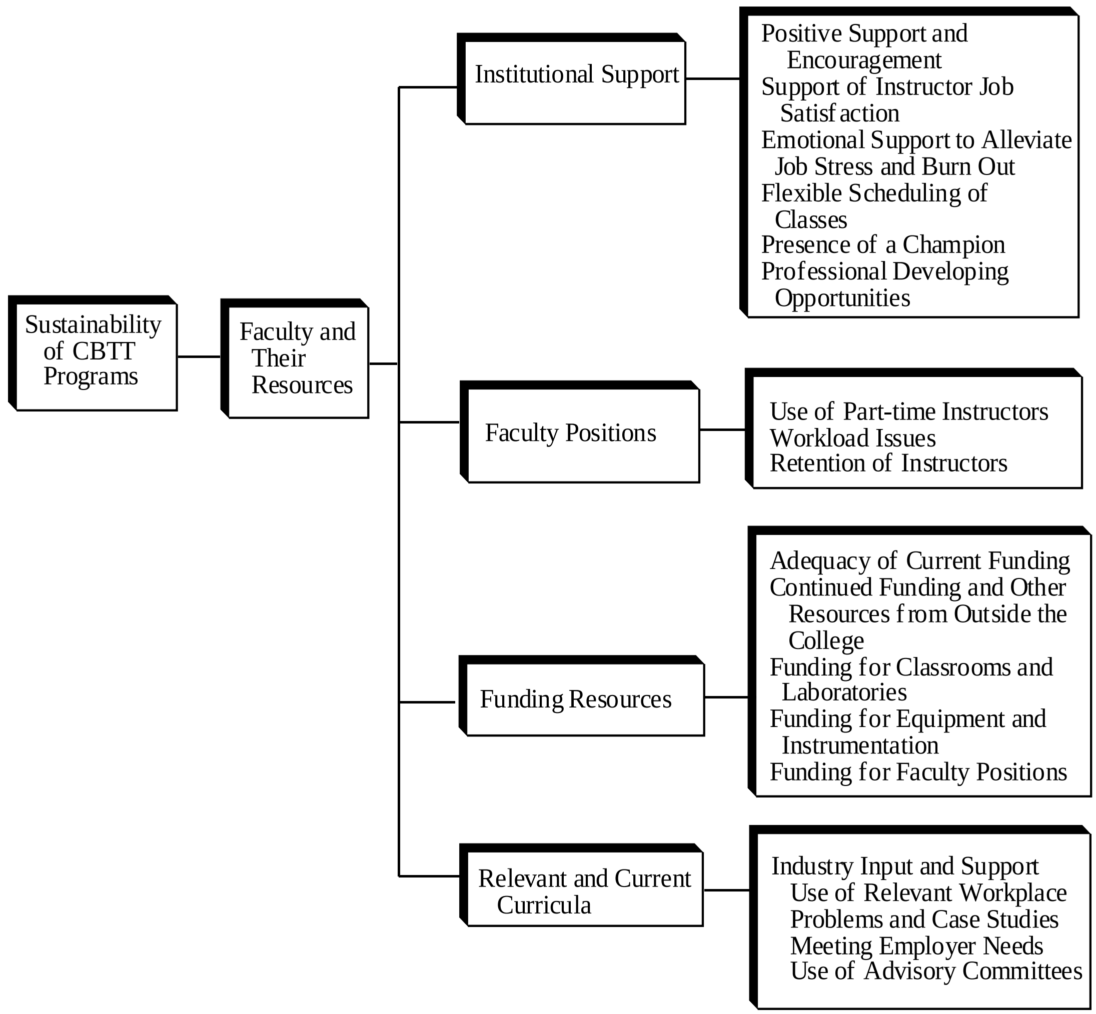

Figure 5: Faculty and their resources with related sub-factors associated with sustainability of CBTT programs.

Community Perceptions and Marketing Strategies

The sustainability of professional technical training programs is related to a community college's ability not only to retain and educate students but also recruit them. The numbers of students in programs are strong indicators to a community college of a program's sustainability (Lawrenz & Keiser, 2001). The ChemTechLinks' report stated, "Attracting a sufficient quantity, quality, and diversity of students is a challenge for many chemical technology education programs" (ACS, 2006b, p. 7). The purpose of this subsection is to indicate how the sustainability of CBTT programs may be influenced by (a) perceptions of the chemistry-based technology profession; (b) community awareness of community college training programs; and (c) marketing strategies used to improve awareness, perceptions, and recruitment of students to CBTT programs.

Community Perceptions of the Chemistry-Based Technician Profession

Undeniably, positive community perceptions in attracting students are essential to the sustainability of professional technical training programs in community colleges. A widespread obstacle to attracting students into science professions, especially ones that are chemistry-based, has been the stereotype of an intellectual misfit, or "geek." Those that do choose science as a profession often go directly to four-year programs (Dalton, 2004), thus increasing the problems of attracting students to two-year professional technical training programs at community colleges.

Although the image of the chemistry-based technician profession has improved greatly within the chemical industry over the past 40 years (Engleman, 2005), it has endured a negative perception by the general public. Even today, technicians are generally considered to have labor-based jobs rather than scientific careers (ACS, 2006b), and through the years there has been a struggle for legitimacy for chemistry-based technicians as a profession (Dalton, 2004). However, a PACT survey (Stander, et al., 2000) of chemistry-based technicians indicated that nearly 90% of the respondents agreed or strongly agreed that they saw themselves as professionals. Another issue of perception is a traditional distrust of chemists (Beall & Berka, 1990) which has been compounded by a pervasive fear or distaste of chemistry (ACS, 2006b; Kenkel, 1990). Kenkel went so far as to recommend that the words "chemistry" or "chemical" should be removed from the name of a CBTT program. He also stated that one program used the name "Research Laboratory Technology" (p. 383) to avoid the overtone associated with chemistry. To make matters worse, the public perceives the two-year degrees that many technicians earn as being substandard, and less prestigious than four-year degrees.

In summary, a community's perception of the two-year college, chemistry, and the chemistry-based profession, may influence many aspects of CBTT programs, such as enrollments and retention. Community perceptions refer to the viewpoints of individuals with respect to the chemistry-based technician profession. In addition to the community's perception of the chemistry-based technician profession, the current study examined the local awareness of CBTT programs.

Community Awareness of CBTT Programs

The PACT survey (Stander, et al., 2000) of current students, employed chemistry-based technicians, and program faculty investigated the reasons why individuals enrolled in CBTT programs. Current students and employed chemical technicians both ranked local job availability and potential wages near the top of the list. This implies that principal community college strategies to attract students should include promoting awareness of the availability of local employment and the substantial financial rewards of chemistry-based technician jobs.

When current students were asked in the PACT survey (Stander, et al., 2000) how they first heard about CBTT programs, three of their top four sources of information were from the college, with brochures being the main source. This implies that community colleges must assume primary responsibility for promoting the awareness of CBTT programs. This issue was addressed in the current study of sustainability by the examination of the degree of community visibility of CBTT programs. Promoting awareness of professional technical training programs is a challenging endeavor and requires considerable support of the college (Zinser & Lawrenz, 2004).

In summary, community colleges must identify the reasons local students are attracted to chemistry-based technology and employ strategies to promote awareness and stimulate interest in their training programs. Community awareness refers to the local visibility of the CBTT program. One area of college support in promoting awareness comes in the form of effective marketing strategies and plans.

Marketing Strategies

Without effective marketing professional technical training programs can often go unnoticed by potential stakeholders. The promotion of any professional technical program involves identifying the public, setting goals, and selecting and implementing a mix of marketing strategies (Shubird, 1990). Plans include surveying community needs, contacting local businesses, making public announcements, giving speeches for civic organizations, providing news releases, and seeking support through funding.

A logical approach to developing a marketing plan would be to specifically target students with professional technical interests. That strategy was employed by a community college in Maryland having the following goals: (a) gather data for community image improvement, (b) continue the image-building process through program improvement, (c) increase college participation in marketing, (d) increase transfer students' awareness of program quality, (e) increase non-traditional and minority students' awareness of technical training opportunities, and (f) increase the awareness of the benefits of a college education (Turcott, 1990). These basic strategies have been used by other institutions to promote professional technical training programs, such as the ATE Centers of Excellence at the South Carolina Technical College System, Chemeketa Community College, Oregon, Bellevue Community College, Washington, and Sinclair Community College, Ohio (Mahoney & Barnett, 2000).

Research associates of the NSF-funded ATE programs recommended that the use of promotion and marketing resources need attention to enhance the sustainability of programs (Lawrenz & Keiser, 2001). Their suggestions included the use of the Web, conferences, publications, professional organizations, and trade shows in order to raise awareness, promote acceptance of programs, and increase enrollments. To help deal with the problem of low enrollments, a general marketing plan for chemistry-based technology degree programs was developed by PACT with the support of an NSF grant. Its goal was to market community college chemistry-based technology training opportunities to the nontraditional and traditional student and to identify and establish relationships with all stakeholders involved in the process. The marketing methods highlighted included: (a) Strengthening relationships with industry, career centers, and employment agencies; (b) developing brochures, videos, and campus Web sites to deliver information about CBTT career opportunities; (c) using the media; and (d) organizing job fairs and speakers to provide information about the profession (PACT, n.d.).

The PACT research profile study (Stander, et al., 2000) recommended that marketing decisions should be made with awareness that more than half of chemistry-based technology students are nontraditional students. The study indicated that the most common range of ages of CBTT students was 20-24 years, with over half of the students over 25 years. The study also recommended that recruiting efforts should emphasize availability of jobs (both locally and nationally), potential wages, and the chemical nature of the career. The ChemTechLinks report (ACS, 2006b) maintained that many respondents suggested that marketing procedures have failed to convey the potential for a rewarding career in chemistry-based technology. The report asserted that technology education programs have not developed effective marketing practices that ensure the recruitment and retention of students. The report pointed out inadequate recruitment practices in: (a) Improving awareness of chemistry-based technician careers in grades 7-12, (b) correctly describing CBTT programs, (c) undertaking special outreach to nontraditional students, (d) describing career paths to industry, and (e) promoting transfer to four-year degree programs. Although students in CBTT programs are predominately non-traditional students who are several years removed from secondary schools, this does not imply that the recruitment of students from secondary schools is unimportant. The ChemTechLinks study (ACS, 2006b), reported that less than one-fourth of the CBTT programs had career pathway agreements with secondary schools. Additionally, according to the ChemTechLinks report, chemistry-based technology education programs have not developed comprehensive effective marketing practices that ensure the recruitment and retention of students.

Research has indicated that representatives of community colleges face an involved and complex process of informing diverse groups of their professional technical training opportunities (ACS, 2006b; Brand, 1997; Gibbs, 2005; Grubb, 1999b; Kenkel, 1997). These groups include regional businesses, various levels of government, nontraditional students, and high school students. Brand (1997) indicated that presidents felt they were hampered by the complexity, costs, and personnel involved in multifaceted marketing efforts. The degree to which a college's marketing plan contributed to the enrollment of students in a CBTT program was investigated in the current study. Committed and effective marketing strategies potentially play an important role in raising community awareness of careers in chemistry-based technology and improving the negative perceptions by the community and prospective students.

In summary, colleges need to develop marketing plans that include a variety of methods that target students with professional technical training interests. A college marketing plan is an effective marketing strategy and its methods of implementation. The marketing efforts should highlight job availability and wages to traditional, nontraditional, and secondary students.

Summary

There is a need to raise awareness and counter misconceptions held by the community regarding chemistry-based technology as a career. The responsibility for these undertakings is unmistakably on the shoulders of community colleges. Research data indicated that individuals were primarily attracted to CBTT programs through college related sources of information. Additionally, current students and chemistry-based technicians were attracted to the chemistry-based technician profession primarily by local job availability and prospective good wages. Information about CBTT programs must be made available to the community to enhance the perception of chemistry-based technology careers and promote awareness of two-year training programs.

For the current study, “community perception” was defined as community awareness and attitudes toward CBTT programs. In addition, “marketing strategy” was operationally defined as the implementation of a comprehensive plan to attract and enroll students in CBTT programs. Sound marketing plans must be formulated with an understanding of strategies needed to recruit and retain students to support CBTT program sustainability. Positive perceptions and the extent of community awareness were addressed in the current study along with marketing plans and promoting CBTT programs to local secondary school students. The promotion of the CBTT program refers to the action taken by the college to promote awareness of CBTT programs. See Figure 6 for an illustration depicting the factors and associated sub-factors of the clustered category “Community Perceptions and Marketing Strategy.

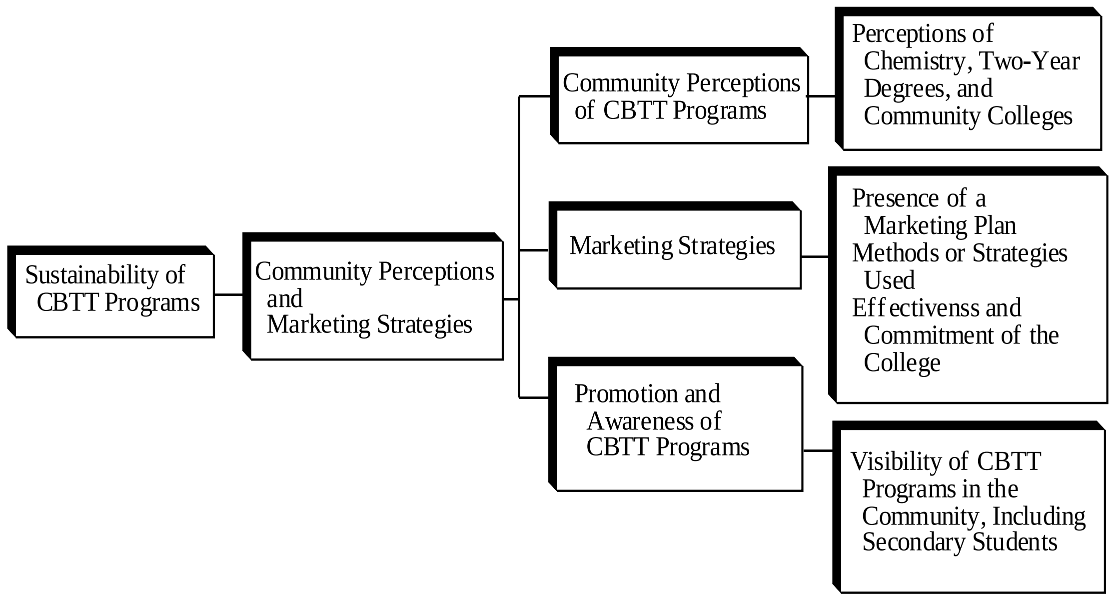

Figure 6: Community perceptions and marketing strategies with related sub-factors associated with sustainability of CBTT programs.

Summary of Review of Literature

This section of the current study described the criteria and procedures used for the selection of literature relevant to the sustainability of chemistry-based technology training programs. Descriptions of the professional status and changing roles of chemical technicians were given to provide an understanding of the perception of the chemistry-based technology profession and its training needs. The different types of sustainability were described, along with some overlapping characteristics. The literature also assisted in the development of an operational definition of economic sustainability as it applies to chemistry-based technology training programs.

The current research found substantive connections among the nine critical issues reported in the ChemTechLinks research as well as additional factors identified in other literature reviewed. As a result, four clustered independent variables emerged: (a) partnerships, (b) employer and student educational goals, (c) faculty and their resources, and (d) community perceptions and marketing, see Figure 2. The clustering of the factors permitted this researcher to organize the recognized factors into manageable categories that permitted survey participants to focus attention on the overarching categories that encompass significant related sub-factors associated with program sustainability. For example, experiential learning, one of the nine critical issues, was identified as a sub-factor related to partnering with business and industry. Therefore Partnerships was established as a category in which the associated factors, such as experiential learning, could be clustered. Similarly, because students in professional technical programs seek education that provides them with job training and employers need well-trained workers, this researcher felt these goals coincide with each other. Therefore the factors or components of the relationships between student and employer goals were assimilated under one category, Employer and Student Educational Goals. Faculty and Their Resources was a category that not only included factors related to the instructor and instructional methods, but also the resources that support faculty. Finally, this researcher felt that factors associated with a process for enhancing program awareness and public perceptions for the promotion of CBTT programs to prospective students could be combined into the category of Community Perceptions and Marketing Strategies.

Partnerships have been found to be influenced by college responsiveness to community needs, the presence of a “champion,” collaboration with industry, and experiential training opportunities. Employability skills, goal attainment, and transferability were important aspects of Employer and Student Educational Goals. The effects of issues and resources on faculty, such as workloads, institutional support, professional development, facilities, equipment, and funding were sub-factors in Faculty and Their Resources. Community perceptions of chemistry-based technology as a profession have been found to be important in student recruitment and retention in CBTT programs. Perceptions and effective marketing strategies to promote training programs for chemical technicians were identified as being important to program sustainability in Community Perceptions and Marketing Strategies.

Each of the clustered categories consisted of sub-factors that were used for: (a) background and understanding of the associated characteristics, (b) development of operational definitions for the current study, and (c) determination of variables to be studied in relation to CBTT program sustainability, see Figures 3, 4, 5, and 6. The relative importance of these clustered categories and the interrelationships of the sub-factors to CBTT program sustainability were investigated and analyzed according to the procedures described in the design of the current study. Figure 7 provides a conceptual framework for the overall study.

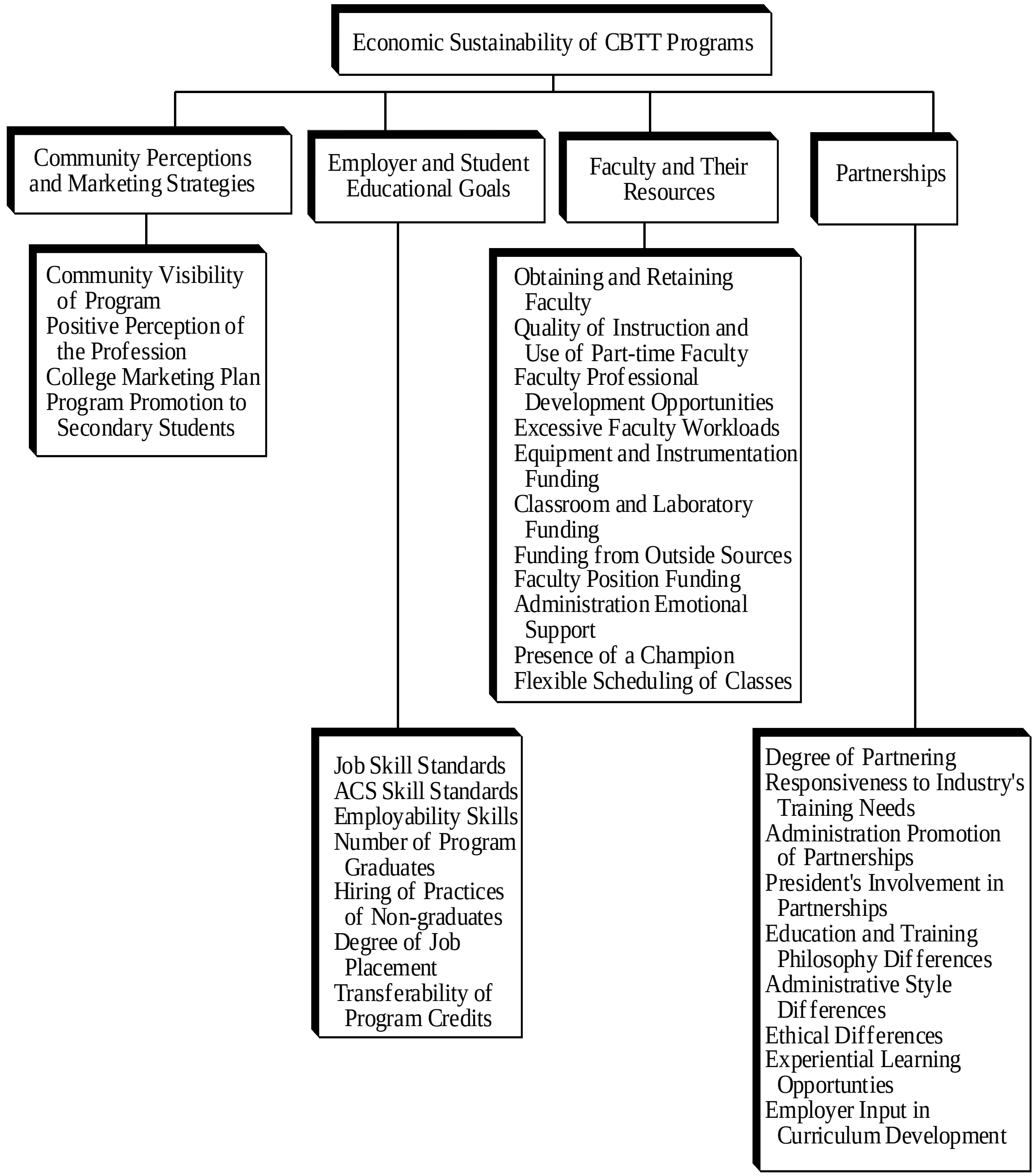

Figure 7: Overall conceptual framework of the clustered categories and the associated sub-factors.

Implications for the Design of Study from the Review of Literature

The purpose of this subsection is to discuss the studies in the review of literature that were research-based and to describe how their methods and findings contributed to the design of my study. Two main studies, the ChemTechLinks report and the PACT research, contributed to the identification and clustering of various factors into four main categories, see Figures 1 and 2. A review of the literature pertaining to the four main categories and their sub-factors (independent variables) related to CBTT programs revealed a variety of research methods and analyses. Although significant in providing insight into the sub-factors for the current study, most of the literature's conclusions did not offer substantial guidance to community college leaders who seek CBTT program sustainability.

The literature reviewed included both qualitative and quantitative studies of partnerships between industry and community colleges in professional technical training. Brand (1997) used interviews with college presidents, and Schmidt (1998) investigated differences between students in different training programs, using rating scales and inferential statistics. These studies, while informative, applied only to the opinions of community college presidents and students and did not address faculty or management involved with professional technical training.

Student and industry goals in professional technical training programs have been studied qualitatively through on-site visitations and focus-group discussions. Interviews with company managers, as well as student satisfaction surveys, were used by Zinser (2003) and Zinser and Lawrenz (2004) in a study of ATE programs. Quantitative research was accomplished through student records and survey data of program participants. Lohman and Dingerson (2005) used a descriptive and experimental design to study the effectiveness of professional technical programs in meeting student and institution goals. The relationship between student goal attainment, in the form of acquiring a job and transferability of program credits, deserved attention in the current study of CBTT program sustainability, and was assessed through the surveyed opinions of administrators and faculty.

Literature research on faculty and their resources came mainly from studies of turnover and retention (Ruhland, 2001), job stress and burnout (Brewer & McMahan, 2004), and job satisfaction (Brewer & McMahan-Landers, 2003) of professional technical instructors. Each study used survey data with analysis of variance or step-wise multiple regression statistics. The statistical analyses, although similar to methods in the current study, yielded information that was limited to the personal characteristics of faculty. The current study probed into additional variables, such as funding, professional development, and institutional support.

Community awareness research surveys, such as the PACT survey (Stander, et al., 2000), provided descriptive information that may be used to develop marketing plans for professional technical training programs. No associational or inferential statistics were applied in the research-based literature pertaining to community perceptions and marketing strategies as they apply to program sustainability. To address this issue, ratings of community perceptions and awareness, along with college marketing plans, were statistically analyzed in the current research.

Many of the findings of the research studies described in this subsection contributed to segments of the current research. Several studies brought to light sub-factors that were further investigated with regard to the sustainability of CBTT programs. Some survey methods and statistical analyses, such as Likert scale ratings, analysis of variance (ANOVA), and multiple regression analysis, found in the review of literature were considered appropriate for the current study. The qualitative data from interviews, observations, and focus-group discussions provided insight into the factors related to the sustainability of CBTT programs. Although I chose a quantitative approach in the current study, one qualitative open-ended research question was included in the survey. This question was provided to allow participants the freedom of expression regarding other issues relevant to CBTT program sustainability. Because much of the research in chemistry and science education is predominantly based on quantitative data, I feel that the quantitative presentation of data and its interpretations will be appealing, meaningful, and legitimate to individuals associated with chemistry-based education and training. The design of my study was formulated after an assessment and critique of the research pertaining to professional technical training programs. The quantitative design allowed for an analysis of interrelationships of factors relative to program sustainability and an analysis of the differences in the opinions between administrators and faculty.

CHAPTER 3

Methods

The purpose of this study was to identify, examine, and analyze the most significant factors associated with economic sustainability of two-year chemistry-based technology training programs. This section outlines the design for the current study and the rationale for the preferred approach. Included in this section is a philosophical approach to the research design, related experience of the researcher, the research method, data needed, participants, data collection methods, data analysis procedures, strategies to ensure soundness of data, and the protection of human subjects.

After teaching and studying the natural sciences for over 20 years, my vantage point is associated with the positivist's philosophic approach. However, common sense associated with critical realism in educational research has resulted in a philosophic approach that embodies a postpositivist point of view. The postpositivist critical realist is aware of the fact that all observations are imperfect and that all theories are revisable (Trochim, 2006). A brief exploration into the characteristics of positivism and postpositivism will provide a foundation for understanding the approach for the current study.

Methodology

The purpose of this subsection is to provide a background of positivism and postpositivism philosophies and the reasons why I chose postpositivism to guide the design of my study. Positivism originated in the nineteenth century with Auguste Comte being credited with having first coined the term *positivism* (Zammito, 2004), referring to his “positive philosophy” (Bredo & Feinberg, 1982, p. 13). Comte believed that all science fell under one model and one method, which were first established by mathematics and the physical sciences. This belief resulted in the inducement of scientism, the conviction that the scientific method can be used to acquire knowledge, regardless of the type of science (Zammito, 2004). Positivists believed the scientific method to be the only tool for accessing truth and reality, thus being able to understand the world so that phenomena could be predicted and controlled (Krauss, 2005). The epistemology of positivism also contended that the only way of obtaining knowledge was through direct observation and experimentation (Trochim, 2006), with the researcher maintaining a value-free, detached point of view (Healy & Perry, 2000). Positivists felt that only analytic statements (true by definition) or synthetic statements (true or false by virtue of experience) should be accepted as meaningful (Bredo & Feinberg, 1982). Delineating knowledge in this way was supposed to distinguish between that which is scientific and that which is not. Thus, an emphasis was placed on logic, rigor, mathematical practices, better experimental procedures, and correlational control which resulted in a dominance of the positivistic approach to research (Bredo & Feinberg, 1982). Positivists believe that knowledge, in general, exists in three forms: (a) particular observations, (b) laws or empirical generalizations, and (c) theoretical statements and definitions (Bredo & Feinberg, 1982).

Critics of the positivist philosophy disagreed with two specific areas. The first was the relationship between theory and observation, and the second was the positivist view of explanation of the observations being made (Bredo & Feinberg, 1982).

Positivists believe that objectivity is a characteristic that resides in the researcher (Trochim, 2006). Because theories are based upon examples which are observed from a holistic viewpoint by an individual (Bredo & Feinberg, 1982), the problem becomes one of subjectivity for which there is no room in positivism. Although true objectivity is difficult if not impossible to obtain, most positivists believe that utilizing appropriate research methods will provide objective results (Guba & Lincoln, 1994). However, each individual researcher sees things in different ways with a variety of views of the world. The researcher or scientist, being a part of the social world, cannot be completely detached from the observations he or she makes; but instead, the researcher is in actuality an integral part of the world. As such, the scientist is subject to using applications that are a product of the social interactions of her or his community. This implies that the theories and observations are not logically independent of each other as indicated by the philosophy of positivism (Bredo & Feinberg, 1982). Furthermore, if the social scientist does not recognize that the applications or conventions being used may be different from those of the subjects in the study, a dilemma can exist within the communication between the knower and the known.

The second argument critics make is that the positivists' explanation of an observation consists of formal rationalization or logical deducibility which does not take into account substantive or practical rationality (Bredo & Feinberg, 1982). "On this account, then, the positivistic view of the nature of explanation and of the grounds on which even the most rigorous sciences accept or reflect theories is much too narrow" (Bredo & Feinberg, 1982, p. 24). This implies that explanations require interpretation if they are going to be applied to practical circumstances.

Around the middle of the 20^{th} century, a shift away from positivism toward postpositivism occurred (Guba & Lincoln, 1994). The postpositivists recognized that there is no neutral observation free from theory. "What counts as an observation, and the interpretation or meaning of observation terms is at least partly [theory-] dependent" (Zammito, 2004, p. 10). Furthermore, as Nietzsche (1965) once wrote "there are no facts, only interpretations" (p. 40). Trochim (2006) indicated that the postpositivist recognizes that the way scientists think and work, combined with the way we think in our everyday lives, are not all that different. He took this viewpoint one step further, suggesting that scientific reasoning and common sense reasoning are essentially the same process. There is, however, a difference in the degree to which the reasoning is taken. For example, scientists perform experiments by following specific procedures, collecting data from observations that are verifiable, and recording accurate and consistent results. In our everyday lives we do not usually use such disciplined methods, yet there is a connection between individuals who seek answers to questions and those who do research.

Criteria for Truth

The goal of research from the postpositive perspective is the discovery of true statements or theories about certain situations. The principles used by this researcher to establish the methods used in the current study are discussed in this section. According to Schutt (2004), the use of a postpositivist approach requires that the researcher follows a set of guidelines that minimizes potential biases or research errors. The postpositive researcher seeks beliefs that have been generated through rigorous empirical investigation and are likely to be true (Phillips & Burbules, 2000). According to Phillips and Burbules, research should be guided by the best knowledge currently available while looking at the supporting evidence. Schutt (2004) indicated the need to be vigilant in: (a) Not becoming too involved in an outcome, (b) making clear assumptions, and (c) being skeptical of current knowledge. The postpositivistic spirit is one that embodies the perception that we should do as much as humanly possible to maintain an open mind and ensure that our beliefs are justifiable, uphold standards of truth, be reasonably unbiased, and open to criticism (Phillips & Burbules, 2000). Every source of knowledge should be open to critical examination, asking whether the assertion made is true, and if it agrees with the facts as interpreted by others. Open criticism of the research is the best safeguard we have that errors, assumptions, values, and biases will be identified (Phillips & Burbules, 2000). These guidelines will be discussed later in this chapter when strategies to ensure soundness and data analyses are examined. Finally, postpositive researchers generally make use of various aspects of their background knowledge and assume this to be unproblematic for the purposes of the particular inquiry in which they are interested.

Personal Disclosure

In a positivistic approach to research, the researcher is thought to be objective and removed from the research process, and therefore there is no need to know about their perspectives, experiences, and values. However, as described above, in the postpositivistic approach, it is recognized that the researcher is not able to be completely objective. In addition, postpositivism maintains that what is accepted as real is dependent upon the theoretical or cultural framework of the observer. With this in mind, I am providing some background on myself as researcher for readers to take into consideration as they attempt to generalize from my study data, findings, and recommendations.

My personal background as a long-time community college chemistry instructor played a significant role in the selection of this research topic, purpose, and determination of my research approach. As a community college chemistry instructor, I am committed to improving chemical education for both academic and professional technical students. My recent experience with an accelerated training program for chemistry-based laboratory technicians generated an interest in professional technical training. Prior to this program my experience was limited to academic studies. While investigating the possibility of implementing a training program at my institution it became apparent that several previously operating CBTT programs throughout the U.S. were no longer in existence. This information further stimulated my interest in determining the most important factors associated with CBTT program sustainability. It is my hope that this research will provide information to assist community college faculty, administrators, and political leaders in making sound decisions regarding CBTT programs.

Although the postpositivist philosophy recognizes that the researcher is inherently biased by their experiences and view of the world (Trochim, 2006), the design of my study reflects a research method that is realistically objective and is based on sound statistical analyses. Postpositivists should have an understanding that a “true” explanation or observation is: (a) based on facts, (b) logical, and (c) replicable (Zammito, 2004). This researcher strived to maintain, as closely as possible, an objective view of reality. Bearing this in mind, one goal of the current study was to add to the research community's current perception of reality by examining and analyzing the relationships among selected variables that impact the sustainability of CBTT programs.

Method

The postpositivist approach was used in the current study, because it fits the research purpose: to identify, examine, and analyze the most significant factors associated with the economic sustainability of CBTT programs. The many and varied factors influencing the sustainability of CBTT programs need to be examined not only from the quantitative survey data, but from a perspective that uses the findings to reach rational conclusions. Two reports regarding CBTT programs provided invaluable information in assisting in the determination of these factors: (a) A PACT report (Stander, et al., 2000), and (b) a ChemTechLinks report (ACS, 2006b). It is my intention that the current study adds to, or complements, the research objectives of the PACT and ChemTechLinks efforts--the improvement of chemistry-based technology education and training. The current study examined the perspectives or "realities" of the faculty and administrators of CBTT programs using a cross-sectional survey in which statistical methods were employed to analyze the results, draw conclusions, and provide implications for the CBTT community of educators.

Cross-sectional Survey

A cross-sectional survey was used to examine the most significant factors associated with economic sustainability of two-year CBTT programs. The cross-sectional survey was designed to obtain information on program characteristics and the perceptions of program participants regarding the relationships of the factors influencing sustainability. A postpositivistic philosophy is evident, because the data collected were analyzed with a view of obtaining true explanations based on “real world” perspectives of the CBTT participants.

The following characteristics of cross-sectional surveys are displayed in the current research (Creswell, 2005): (a) Data were collected at one point in time, (b) data collected included current attitudes, opinions, and beliefs, and (c) a comparison was made of two or more groups. The current study used descriptive, associational, and inferential statistics to describe, analyze, and evaluate the relationships among the identified factors related to CBTT program sustainability. Although the current study quantified the correlations between the variables, its primary purpose was not to determine cause and effect relationships but rather to investigate and identify associated relationships.

Data Needed

The data needed for the current study were guided by the following research questions: (a) What is the relative importance of the identified factors relating to economic sustainability of CBTT programs? (b) What differences exist between the opinions of administrators and faculty with regard to the factors associated with CBTT program sustainability? and (c) What are the interrelationships among the factors related to the economic sustainability of CBTT programs?

Data were collected using an electronic survey from CBTT program participants across the U.S. in order to evaluate the relationships between the independent variables (clustered categories and their sub-factors) and the dependent variable (sustainability). In the design of the current study, the term "sub-factor" was used to indicate a procedure, event, or policy that contributed to a resulting characteristic or attribute of a CBTT program.

Dependent Variable. A dependent variable is an attribute or characteristic that is influenced by an independent variable (Creswell, 2005). In the current study the dependent variable was the sustainability of CBTT programs. Sustainability was chosen as the dependent variable after its importance became evident from the critical issues report from ChemTechLinks (ACS, 2006b) and my review of the literature. For the current study sustainability was defined as continued program activities with observable benefits or outcomes for stakeholders. This definition was developed from the research indicated in the review of literature.

Independent Variables An independent variable is thought to influence or affect the dependent variable (Creswell, 2005). For the current study, a review of related literature, including the PACT and ChemTechLinks reports, along with personal background, provided a conceptual framework leading to the collection of factors into four independent variables related to the sustainability of CBTT programs: (a) partnerships, (b) employer and student educational goals, (c) faculty and their resources, and (d) community perceptions and marketing strategies. These independent variables will be referred to as “clustered categories” of factors because they include several sub-factors related to the sustainability of CBTT programs. A cluster is a grouping of factors that are assumed to have strong associations within the category but minimal associations with factors in other categories (StatSoft, 2004). Tables 1, 2, 3, and 4 provide operational definitions for each of the four independent variables including the associated sub-factors (clustered categories and their sub-factors).

Table 1: *Operational Definitions for the Clustered Category of Partnerships and the Associated Sub-Factors*

Independent Variables	Operational Definition
Partnerships	Cooperative efforts or agreements between colleges and business and industry to pool resources for mutually acceptable purposes in CBTT programs.
Responsive college	College's reaction to industry's training needs.
Promotion of partnerships	College's influence and activity in the development of partnerships with business and industry.
President's involvement in partnerships	The college president's support in strengthening the effectiveness of partnerships with business and industry.
Differences in educational training philosophies	Variation in the approach to education and training between the college and business and industry.
Ethical differences between the college and business and industry	Moral decision-making affecting partnerships in program development.
Differences in administrative styles	Variation in managerial and directional support for training programs.
Industrial experiential learning	Student opportunities through multi-venue training or internships.
Collaboration in curriculum development	Cooperation between the college and employers in developing CBTT program curriculum.

Table 2: *Operational Definitions for the Clustered Category of Employer and Student Educational Goals and the Associated Sub-Factors*

Independent Variables	Operational Definition
Employer and Student Educational Goals	Common educational objectives of employers and students related to employability skills and job attainment.
Employability skills education	Broad-based integrated job skills education to include adaptability, teamwork, problem-solving, and effective communication.
Program completion rates	Student completion of a CBTT program with a degree or certificate.
Business hiring practices of non-graduates of programs	Offer of employment to students prior to completion of the program.
Job placement of CBTT program students	Students obtaining employment in a chemistry-based field.
Program credit transferability	Potential for coursework and credit to be transferred to a four-year institution.
Job skill standards or guidelines	Specific job skill standards developed by leaders of regional business and industry, state labor boards, or the ACS.

Table 3: *Operational Definitions for the Clustered Category of Faculty and Their Resources and the Associated Sub-Factors*

Independent Variables	Operational Definition
Faculty and Their Resources	Instructors and the supporting instructional resources available from the college, business and industry, and/or community.
Recruitment and retention of faculty	Obtaining and retaining CBTT program faculty.
Quality of instruction and use of part-time faculty	Effect of the use of part-time instructors on the quality of education.
Professional development	Opportunities for faculty to improve subject matter proficiency, currency, and teaching effectiveness.
Excessive faculty workloads	Abnormally high teaching assignments and additional duties or responsibilities.
Funding	External and internal funding for faculty positions, facilities, equipment, and instrumentation.
Emotional support of faculty from administrators	Encouragement in morale building and job satisfaction for program instructors.
Champion	A leader that effectively advocates for support of the program.
Flexible scheduling	Offering classes at non-traditional times or alternative venues.

Table 4: *Operational Definitions for the Clustered Category of Community Perceptions and Marketing Strategies and the Associated Sub-Factors*

Independent Variables	Operational Definition
Community Perceptions	Community awareness and attitudes toward CBTT programs.
Marketing Strategies	Plans for attracting and enrolling students.
Community awareness of the CBTT Program	Visibility of CBTT Programs.
Community perceptions of chemistry-based careers	The viewpoints of individuals with respect to the chemistry-based technician profession.
Marketing plan	An effective marketing strategy and its methods of implementation.
Promotion or marketing of CBTT programs to secondary students	Action taken by the college to promote awareness of CBTT programs and associated careers to high school students.

Consistent consideration of the operational definitions of the dependent and independent variables assisted in determining the data needed to answer the research questions and the development of the survey instrument.

The Instrument

The survey instrument (Appendix A) requested background and demographic information, such as the respondent's name and job title, the college name, description of the program, the program's current activity, number of students enrolled, years in operation, and characterization for the future demand for CBTT program graduates, see Table 5. In order to determine the magnitude of sustainability, respondents were asked to select a rating from a five-point Likert scale that characterized their program.

The survey instrument also consisted of 31 Likert scale rating statements, one item for a ranking of the importance of the clustered categories, and one open-ended question.

Table 5: *CBTT Program Sustainability Survey Components*

Demographic information	Eight questions related to the college, participant's position and program description.
Rated sustainability criteria	One question for rating program sustainability.
Rated factor related to Sustainability	Thirty-one questions for rating sub-factors' relationship to sustainability.
Ranked importance of clustered categories	One question for the ranking of importance of each of the clustered categories to sustainability of CBTT programs.
Open-ended question	One open-ended question related to additional factors pertaining to sustainability.

The current study's instrument was used to assess the relative importance of the clustered categories of factors and the interrelationships of sub-factors related to the sustainability of CBTT programs. The commonly used Likert scale is well-tested in survey research and assumes theoretically equal intervals (Creswell, 2005). Interval scales allow "continuous" response options to questions or statements. The Likert scale for the current study allowed for five options (strongly agree, agree, neither agree nor disagree, disagree, and strongly disagree). Although the answers to a Likert scale question gives a rating, responses using this scale are actually in a rank-order. Using a Likert scale to rate opinions posed some threat to validity from the assumption of equal intervals and controversial treatment of the data as quantifiable (Vogt, 2007). The assumption of equality between numbered ratings on the Likert scale is acceptable for statistical analysis in research surveys (Nardi, 2006). Table 6 shows the specific data needed from the survey instrument in order to answer each one of the research questions. In addition, it was believed that the inclusion of a qualitative open-ended question would enhance the quantitative analysis and improve this researcher's understanding of the findings. It was felt that using this method of data collection would provide a meaningful and comprehensive investigation into the factors influencing the sustainability of CBTT programs.

Table 6: *Research Data Needed*

Research Questions	Data Needed
What is the relative importance of the identified factors relating to economic sustainability of CBTT programs?	The survey participants' rankings of the clustered categories.
What differences exist between the administrators and faculty with regard to the factors associated with CBTT program sustainability?	The position title of the participants, rankings of the clustered categories, and Likert scale ratings of the sub-factors.
What are the interrelationships among factors related to the economic sustainability of CBTT programs?	Likert scale ratings of the participants' program sustainability and the clustered category sub-factors.

Study Participants

The ACS, in conjunction with the NSF funded project ChemTechLinks, publishes the Directory of Chemistry-Based Technology Programs annually. The directory provides contact information for CBTT programs designed to prepare students for chemistry-based careers. Even though the directories list both four-year and two-year college programs, only two-year programs in the U.S. were considered in the current study. The target population for the current study consisted of two faculty and two administrators from 134 two-year CBTT programs that were listed in the ACS directories (ACS, 2006a; ACS, 2007; ACS 2008). Although this researcher was interested in obtaining the names of two faculty members and two administrators from each college; it was found that many of the smaller programs had less than four individuals who were knowledgeable about their CBTT program. Therefore, the target population consisted of those individuals who were actually sent surveys. The sample consisted of those participants who returned completed surveys.

Survey Dissemination and Data Collection Procedures

This researcher contacted, through email, each of the 134 CBTT program contacts listed in the ACS directories and requested the names of two instructors and two administrators having knowledge of their CBTT program. In the cover letter, this researcher noted her position as a faculty member in a community college. Oftentimes individuals are more motivated if someone they can relate to requests their participation. In fact, this appeared to have a positive impact on the response rate of participants. Instructors and administrators whose names were provided were contacted through email and asked to participate in the current study, see Appendix B for the study's letters of introduction. Each survey request was sent individually so that multiple recipients did not show in the email addresses (Dillman, 2007). Those individuals who agreed to participate in the study were provided with an Informed Consent Document (See Appendix C) and the opportunity to complete the survey (See Appendix A). Individuals for the study volunteered; thus, making themselves available for participation in the research. This method met the IRB requirement that all participation is voluntary. The correspondence included directions for downloading and completing the survey, saving the information, and returning the survey to this researcher via attachment to the email. All but one participant returned the completed survey as an attachment to an email. The other participant sent the completed survey via U.S. mail. Follow up emails were sent to non-respondents encouraging their participation in the study.

When surveys were returned, hard copies were printed, the surveys were coded, and the raw data was logged into an Excel spreadsheet. The data were double-checked for the accuracy of the input of data by two other individuals. The hard copy of the survey was filed in a notebook as a backup in case of computer failure. The respondents' email was then deleted. This process was to ensure the protection of anonymity of the respondents.

Finally, this researcher sent a thank you note, via email, to the participants for their assistance in the study. This process, although time consuming, provided for a more personal contact with each participant and allowed for questions to be asked of this researcher regarding the study.

Summary

The data needed for the current study consisted of survey rankings and ratings of independent variables influencing CBTT program sustainability from individuals involved in 134 CBTT programs. In addition, participants were asked to indicate other possible factors that may influence program sustainability. Voluntary participation in the study was requested of administrators and faculty members of CBTT programs listed in the ACS directories. Rankings reflected the preferences of the respondents, while ratings indicated the strength of opinions. The preferences of respondents were indicated in the survey through a ranking of the importance of the clustered categories to the dependent variable; while the strength of their opinions was indicated through rating the sub-factors related to the participants' program sustainability.

Collection of the research data consisted of a request for participation which was sent to CBTT program contacts. Once participation was agreed upon, the survey was sent via email to the participants of the study. The majority of the respondents returned the survey via email and the data were collected and assimilated into an Excel spreadsheet.

Data Analysis

The following section briefly describes the statistical methods (descriptive, associational, and inferential) used to answer the three research questions of the current study. Basically, the goals of analyzing the survey data were to: (a) Establish the relative ranking of the importance of the clustered categories of sub-factors related to CBTT program sustainability, (b) investigate differences in the opinions between faculty and administrators, (c) determine strengths of relationships between sustainability and the independent variables, and (d) search for interrelationships among the sub-factors. The ultimate goal of these analyses was to provide educators information that would help establish and sustain effective CBTT programs.

Descriptive statistics were obtained from the rankings of the importance of the clustered variables to the sustainability of CBTT programs. Comparisons of the ranking means provided an indication of how respondents considered the importance of each clustered category to program sustainability. The Mann-Whitney U test of significance was used to determine if there were significant differences between the rankings of small and large program participants.

To evaluate potential differences in the opinions of faculty and administrator participants, the Mann-Whitney U test of significance was applied to the ordered rankings of importance of the clustered categories of factors associated with CBTT program sustainability. The Mann-Whitney U test of significance was also used to investigate possible differences in the ratings of faculty and administrators, as well as small and large program participants. Additionally, MANOVA was performed on the four groups (large program administrators, large program faculty, small program administrators, and small program faculty) in order to make multiple comparisons of ratings of the sub-factors with the sustainability of CBTT programs.

The ratings of each of the program participants' program sustainability were presented in frequency distributions. The ratings of the 31 sub-factors were reported as percentages of Likert scale responses. A correlation coefficient was determined for each sub-factor's rating and the program sustainability rating given by each participant. Multiple regression analysis was used to explore linear relationships and collective effects among the sub-factors and sustainability. In addition, further understanding of patterns of correlation among the independent variables was gained through factor analysis. A summary of the statistical methods chosen to answer each of the current study's research questions is presented in Table 7.

Table 7: *Statistical Methods Used for Each Research Question*

Research Question	Statistical Method
What is the relative importance of the identified factors relating to the sustainability of CBTT programs?	Frequency distributions Means, Standard deviations Mann-Whitney U
What differences exist between the administrators and faculty with regard to the factors associated with CBTT program sustainability?	Means, Standard deviations Mann-Whitney U MANOVA
What are the interrelationships among the factors related to the economic sustainability of CBTT programs?	Means, Standard deviations Frequency distributions and percentages Correlation coefficients Mann-Whitney U Multiple regression

This post-positivistic researcher gathered the qualitative data from the open-ended question in the survey instrument, placed the data in a word document, and subsequently divided the data into categories that were used to identify key components that would assist in answering the current study's research questions. Staying with a post-positivistic philosophy, the comments made by the participants were used directly without editing to add further knowledge regarding each of the clustered categories and their sub-factors as appropriate. In addition, any factors that participants identified that were not included in the current research's survey instrument were suggested for future investigations.

In summary, descriptive statistics were used to describe the survey rankings and ratings of the independent variables (four clustered categories and their sub-factors) as they relate to the dependent variable (CBTT program sustainability). The rankings assisted in determining the relative importance of the clustered categories to program sustainability. The ratings were used to examine correlations between variables through associational statistical analysis. Testing for possible significant differences between the opinions of faculty and administrators, as well as small and large program participants, were also investigated through inferential statistics. Finally, answers to the open-ended question in the survey were examined and categorized by relationship to the pertinent sub-factor.

Validity and Reliability of the Study

In any kind of quantitative research in order for the instrument data to be meaningful and accurate it must be valid and reliable. According to the Joint Committee on Standards for Educational and Psychological Research and Testing (1999), the process of validation involves presenting evidence for a sound basis of the proposed interpretation of data.

Validation of the current study began with the rationale for the current study, which was to provide information to educators for improving the sustainability of their CBTT programs. As mentioned earlier, Schutt (2004) suggested that the postpositivist researcher follows a set of guidelines to minimize bias and research errors. This researcher stayed committed to the following: (a) testing through an objective manner, (b) remaining skeptical toward the new knowledge determined, and (c) making sure any assumptions were clarified.

Objective testing of ideas. An important aspect of my research was to assist community college leaders and other individuals associated with chemistry-based technology training to make decisions that will improve the likelihood for program sustainability. Therefore, testing ideas against external realities in order to draw correct inferences (external validity) was important to the current study.

External validity may be threatened whenever generalizations are made from statistical analyses. Threats to external validity include: (a) A surveyed sample that does not represent the opinions of the target population, (b) the characteristics of programs in one setting do not translate comparably to others, and (c) past and present circumstances may not be generalized to the future (Nardi, 2006). Research should be conducted using the best knowledge currently available while looking at the supporting evidence. The sample for my study came from direct contact with the two-year program contacts listed in the ACS CBTT directories. This researcher asked all program contacts from the U.S. listed in the directories to participate in the current study. Programs outside the U.S. were not included in this study. The data collected from the survey consisted of the perspectives of individuals directly connected with CBTT programs. This implies that the best knowledge currently available was evaluated. In order to support the validity of interpretation of data, differences in the opinions of small and large program participants were statistically investigated. However, the current study did not address geographical or type of program differences. These may be areas for future study involving CBTT programs. In addition, the current situation of CBTT programs may not necessarily reflect future issues or circumstances regarding program sustainability.

Phillips and Burbules (2000) indicated that the postpositive researcher should seek beliefs that have been generated through rigorous empirical investigation. Statistical threats to validity occur when poor choices are made for analysis of the data. Correlation coefficients, multiple regression, Mann-Whitney U, and MANOVA are robust procedures that assisted in making valid interpretations of the findings in the current study. Therefore, any threats to validity in the use of statistics were judged to be not significant.

Remaining skeptical. The postpositivist must maintain, as much as humanly possible, an open mind that ensures beliefs are justifiable, are reasonably unbiased, and open to criticism (Phillips & Burbules, 2000). By retaining an open mind, remaining skeptical, and critically examining the new knowledge, this researcher attempted to ensure that any errors, assumptions, values, and biases were identified. Postpositivists make use of various aspects of their background knowledge, and although this researcher is a community college faculty member, the researcher has only limited experience with a CBTT program.

Clarification of assumptions. The main assumptions at the foundation of the current study were: (a) This research will increase the potential for building sustainable CBTT programs; (b) Faculty and administrators will be better equipped to evaluate factors regarding the sustainability of programs; (c) The variables identified, data collected, results, and interpretations for the current study will provide valuable information for making sound decisions; and (d) The current opinions of CBTT program participants are representative of the population. The current study intended to provide information that will assist in developing or sustaining CBTT programs. Evidence for the validity of research that provides information to CBTT faculty and administrators has been substantiated by the on-going activities of the ACS's ChemTechLinks organization and through the many requests for the results of the current study by survey participants.

In the current study, the interpretations pertained to the perceptions of factors related to the sustainability of CBTT programs by individuals directly associated with those programs. The perceptions were evaluated through a survey instrument that included ratings and rankings of factors related to program sustainability.

Validity of the instrument. Validity of the instrument refers to the relevance and appropriateness of the design or measurement for the research question under investigation for drawing accurate conclusions (Vogt, 2007). Evidence for validity of the current study is closely connected to the survey instrument; including test content, response processes, internal structure, relationships of variables, and the consequences of the survey findings. Test content refers to the format, wording, procedures for the administration, as well as the ratings and rankings of the survey items. The current study established test content validity of the instrument using three strategies: (a) Development of the instrument based on a conceptual framework from the literature review, (b) a review of the proposed survey instrument by a panel of experts, and (c) a pilot study. The legitimacy of the test content of the survey questions was supported through the review of literature, previous surveys by professional-technical organizations, and consultation with a panel of experts in the field of chemistry-based education and training. According to the Joint Committee on Standards for Educational and Psychological Research and (1999), the use of existing evidence from similar research and experts in the field can assist in the argument for validity.

The use of the PACT and ChemTechLinks reports, in addition to other literature, provided an assessment of what factors should be further investigated in the current study. The factors associated with CBTT program sustainability are many and varied, creating the possibility of the omission of some important factors in the current study. However, the inclusion of an open-ended survey question that allowed participants to further communicate additional factors provided some alleviation of this potential threat. In addition, this question provided further substantiation of the factors identified by this researcher from the literature. Most participants elected to comment on the factors under investigation as opposed to indicating further factors.

After the development of the survey, it was reviewed by a panel of experts; two ACS administrators associated with chemistry-based training programs, a community college chemistry instructor, and a physics instructor from a former CBTT program. The Joint Committee on Standards for Educational and Psychological Research and Testing (1999) indicated that by using a diverse panel of experts, potential sources of difficulty in the survey items may be alleviated. The experts were asked to critique the survey statements as to the format, representation of the chosen factors relative to program sustainability, the relationships between the sections of the survey and the constructs, and the wording of the questions. Modifications were made to the survey based on the recommendations of the panel's critique. Modifications included additional wording for clarity, arrangement of questions, and the inclusion of demographic information. Furthermore, following the expert panel review, a pilot study of the survey was conducted with four community college full-time and one part-time physical science faculty. The pilot study served to provide even further evaluation of the test content and assisted in ensuring that the administration of the survey's electronic process was without flaws. The survey was sent individually to program participants by this researcher via email. The survey was sent as an attachment, with instructions for downloading, completing, saving, and returning the instrument to this researcher. This method was used to maximize the response rate for the study. In addition, the survey was reviewed and approved by the Oregon State University Institutional Review Board (IRB).

The internal structure of the survey instrument consisted of several components related to the underlying construct and provided evidence for answering the study's research questions. For example, while the sub-factors of each of the four clustered categories were part of a homogeneous group, each was distinct from each other. The design of the survey instrument allowed for interpretation of survey responses on a single-factor basis, or through possible interrelationships between or among the factors. Relationships among responses of four groups organized by program enrollments and positions of the participants (large and small program faculty and large and small program administrators) provided further insight into whether or not agreements or disagreements were consistent with interpretations of the perceptions.

Reliability. Reliability refers to the consistency of measurements from which different researchers will arrive at similar conclusions (Creswell, 2005; Vogt, 2007). The reliability of a measuring instrument, based on clear operational definitions of variables, is foremost in quantitative research. Operational definitions of key terms were provided in the survey instrument to assist in the consistency of responses by the participants. The participants were asked to rate the identified factors in terms of their relationship to their CBTT program's sustainability. In addition, participants were asked to rank the degree of importance of each of the four clustered categories to program sustainability.

Internal reliability was evaluated in the current study's instrument using one version of the survey which was administered once, and it included different items intended to measure the same underlying construct. For the current research, the primary concern was that individuals should answer questions that were closely related in a similar manner. Nardi (2006) suggested that a popular way to statistically determine reliability is to look at internal stability by analyzing a group of items developed to measure a construct or variable and then compare answers within this group. Cronbach's alpha was used in the current research to determine whether or not survey items thought to measure the same thing were correlated. Cronbach's alpha was appealing for this study, because it suggests through high alpha coefficients that the survey items are measuring the same underlying concept and that Likert scale ratings are reliable. The following Cronbach Alpha equation was used:

$$\alpha = (N/(N-1))(1 - \sum s_i^2 / S^2)$$

Where s_i^2 is the variance for item i, S^2 is the total test variance, and N is the number of items. Cronbach's alpha ranges in values from zero to 1.00. Zero implies the measures are totally inconsistent while 1.00 indicates the items correlate with each other perfectly. An alpha of 0.70 or better is considered satisfactory in education research. This cutoff is used because the R^2 value (or percentage of variance) would be less than 50% if Cronbach's alpha were less than 0.70 (Vogt, 2007). Factor analysis of the survey data identified six components of related factors. The

Cronbach's alphas for each of these components, respectively, were: 0.857, 0.790, 0.770, 0.670, 0.792, and 0.517. See Appendix J for additional information.

Summary. Threats to validity of the research design were addressed through control factors that included an extensive review of literature, attempt to maximize the survey response rate, evaluation of the perspectives of individuals directly involved with CBTT programs, and use of sound statistical practices. In addition, this researcher has clarified the assumptions associated with the current study's intended use and maintained an open-minded attitude throughout the study.

The support of instrument validity comes from an extensive review of literature, appraisals of previous surveys related to CBTT, a review of a panel of experts, a pilot study, and thoughtful design of the survey instrument. The evidence that the study's survey data supports the intended interpretations, including test content, response processes, internal structure, and relationships of variables, indicates the threat to validity in the current study's survey is minimal. In addition, reliability of the instrument was based upon ensuring consistency of responses through the provision of operational definitions and the statistical examination of the participant's survey responses through Cronbach's alpha.

Protection of Human Subjects

The importance of protecting individuals participating in research cannot be overstated. In preparation for the ethical treatment of human subjects in research, this researcher completed the online course, National Institutes of Health Human Participants Protection Education for Research Teams. The proposal for the current study was submitted to the Oregon State University Institutional Review Board Office of Sponsored Programs and Research Compliance to ensure the protection of human participants.

The subjects of the current study remained anonymous, and all of the survey responses remain confidential. Although names were collected, this information was used only in the determination of non-respondents for follow-up requests. All participant names and positions were coded with letters and numbers to ensure anonymity. All surveys were collected via email response and there was no risk to the participant with involvement in the current research.

Requests of participants to complete the study's survey did not involve the loss of any rights if individuals chose not to participate. All responses were voluntary. Participants were informed of the purpose and benefits of the current study as well as their rights and potential risks prior to being allowed to complete the survey instrument. All individuals were sent the Informed Consent Document, see Attachment C.

No monetary gain was provided for completing the survey. The only direct benefit for participating in this survey was that this researcher indicated that the results of the study would be provided to each respondent to assist them in creating or maintaining a sustainable CBTT program.

Summary

In summary, the design of my study reflected personal characteristics that stem from my experience and interest as a chemistry instructor with a research perspective based on a postpositivist philosophy. Using a cross-sectional survey the collection of data from program participants provided the base of information from which analyses and interpretations regarding CBTT programs were constructed. The research procedures, including data collection analyses and interpretations of the findings, were consistent with the postpositivist approach.

The target population of my study consisted of administrators and faculty from 134 two-year CBTT programs. Participants were surveyed for their opinions about four clustered categories and the sub-factors' (independent variables) relationship to program sustainability (dependent variable). Descriptive, associational, and inferential statistics were employed in the data analysis. Descriptive data from the survey included frequency distributions of rankings and ratings of clustered independent variables and their sub-factors, including means and standard deviations. Associational and inferential statistical analyses were used, including correlation coefficients, multiple regression, and multiple analysis of variance.

In addition, strategies to ensure the efficacy and soundness of my research were implemented. Data collection, analyses, and interpretations were guided by my research questions, a valid and reliable survey instrument, meaningful statistical procedures, and a postpositivistic approach that searched for realistic unbiased interpretations. Potential threats to the validity of my study were identified along with responses to minimize the threats. The Oregon State University's IRB policies for the protection of human subjects were followed. My research project's intent was to provide information that may be applied to better decision making for all those involved in making decisions with respect to CBTT programs. Finally, the results of my study may lead to further explanatory or experimental studies that would assist college leaders in making informed decisions and formulating practical plans that lead to sustainable CBTT programs.

CHAPTER 4

Results

The purpose of this study was to identify, examine, and analyze the most significant factors associated with the economic sustainability of two-year CBTT programs. Based on a review of the literature, four clustered categories of sub-factors related to CBTT program sustainability were identified which established the foundation for the development of the survey instrument (See Appendix A). The current study examined the relative importance of the clustered categories with respect to program sustainability. The participants were asked to rank the four clustered categories taking into consideration the associated sub-factors. These rankings were statistically analyzed to determine the relative importance participants placed on Partnerships, Employer and Student Educational Goals, Faculty and Their Resources, and Community Perceptions and Marketing Strategies. In a separate analysis of the issues related to program sustainability, respondents rated each of the 31 sub-factors associated with the study's clustered categories as they pertained to the participant's current program sustainability. From these data, this researcher was able to determine the degrees of association between individual sub-factors and a program's sustainability. Furthermore, the ratings also allowed this researcher to evaluate interrelationships that may exist among the sub-factors related to sustainability. Differences in the opinions of administrators and faculty with regard to the rankings of the clustered categories and the ratings of the sub-factors associated with CBTT program sustainability were also examined.

A postpostivistic approach was taken by this researcher in identifying, examining, and analyzing the factors associated with CBTT program sustainability. The methods included collecting data from quantitative closed-ended questions and a qualitative open-ended question contained in the survey instrument. The study analyzed ranking and rating data using the opinions or perspectives of program participants. Analysis of the data included descriptive, associational, and inferential statistics. All of the quantitative raw data collected from the survey responses were analyzed using the Statistical Packages for the Social Sciences (SPSS). Furthermore, the open-ended question provided an avenue for participants to comment on additional factors that may be relevant to program sustainability. This chapter presents the results of the study as follows: (a) Participant sampling and response rate, (b) demographic descriptive statistics, and (c) quantitative and qualitative results that pertained to each of the research questions.

Participant Sampling and Response Rate

This researcher extended an invitation to participate in the current study to faculty and administrators of 134 programs throughout the U.S. Of the 134 programs, individuals from 63 programs agreed to participate (see Appendix D), yielding a program response rate of 47%, see Figure 8. This researcher hoped to survey two administrators and two faculty members from each of the participating programs, producing a potential for 252 participants (126 faculty and 126 administrators). There were 95 survey respondents, yielding a 38% response rate of prospective individual participants. However, it should be noted that this response rate is conservative, because some smaller programs did not have four individuals that were connected with or had direct knowledge of the CBTT program. Of the participants, 66 were faculty and 29 were administrators. The faculty response rate was 52% and the administrator response rate was 23%.

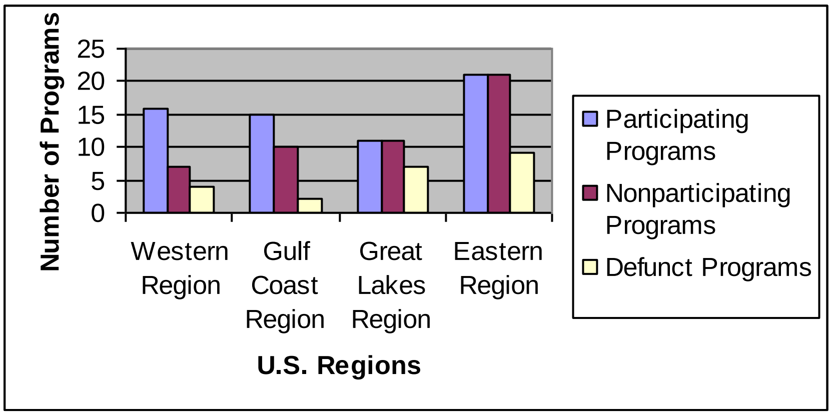

Figure 8: Comparison of participating, nonparticipating, and defunct programs.

The original intent of this study was to investigate both active and inactive CBTT programs. However, this researcher found that of the 134 programs listed in the ACS Directory, 22 of them were no longer in existence as confirmed by the ACS administrators, see Figure 8. This researcher tried several methods to obtain participation from these 22 inactive programs without success. No further follow-up was undertaken to check for non-response bias. Appendix D includes a map of the U.S. indicating participating programs, defunct programs, and non-participating programs.

Demographic Descriptive Data

Part I of the survey, *Chemistry-Based Technology Training Programs: Survey Questionnaire,* investigated CBTT participants' positions at the institution, program activity, program longevity, current enrollments, and future demand for trained technicians. The current study had participants from programs in four general regions of the U.S.: 15 programs from the Gulf Coast Region, 11 from the Great Lakes Region, 21 from the Eastern Region, and 16 from the Western Region. The Gulf Coast region consists of programs in Texas, Louisiana, Mississippi, and Alabama. The Great Lakes states include Minnesota, Illinois, Indiana, Michigan, Ohio, Pennsylvania, and western New York. Eastern states are those roughly east of the Appalachian Mountains, while the Western region lies west of the Mississippi River.

Participants were asked to identify themselves as full-time faculty, part-time faculty, or administrators. The results of this question showed that of the 95 respondents, 60 (63%) were full-time faculty, six (6%) were part-time faculty, and 29 (31%) were administrators.

There was only one respondent from an inactive program; all other program participants indicated at least some degree of activity. If the program was active, the CBTT program participants were asked how long their program had been in existence. The results of this question are shown in Table 8. All of the programs had been in existence for more than one year. Three program participants did not indicate the number of years in existence. This may be due to a lack of institutional history regarding their program on the part of the participant. Interestingly, 54% of the programs had been in existence for ten years or less with half of these programs having less than five years in existence.

Table 8: *Longevity of Participating CBTT Programs*

Number of Years in Existence	Number of Programs	Percentage of Programs
2 years or less	6	10
3 years to 5 years	11	17
6 years to 10 years	17	27
11 years to 15 years	6	10
16 years to 20 years	7	11
21 years to 30 years	9	14
More than 30 years	7	11
	63	100%

Mean	15 years	Standard Deviation	13 years
Median	10 years	Interquartile Range	16 years
Programs	63		

Participants were also asked to indicate how many students were currently enrolled in their CBTT programs. The number of students currently enrolled in the active programs ranged from 0 to 527. The average number of currently enrolled students in all programs was 64 with a standard deviation of 91. The standard deviation indicated the wide range in the number of students enrolled in the 63 participating programs. After looking at the data collected, this researcher recognized that there appeared to be some variance in the opinions of the participants from different-sized programs. Thus, breaking the data down even further by program size appeared relevant to the understanding of CBTT program sustainability. For this study, the median number of currently enrolled students in the CBTT programs was 35. The current study used the median to classify programs as small or large. Small programs were considered to have less than 35 students currently enrolled and large programs had 35 or more students enrolled. This resulted in 30 programs being classified as small and 33 programs classified as large.

Chemistry-based technology training programs have a variety of science-related career objectives. Research participants were asked to describe the type of CBTT program at their college. Of the 63 programs, 46% were laboratory, 36% were process technology, and 18% were laboratory and process technology combined, see Figure 9. Laboratory programs included environmental, chemical, science, engineering, pharmaceutical, and biotechnology training programs. Process technology training programs included paper, applied process, process plant, process operations, bioprocess, and industrial science and operation technology training programs.

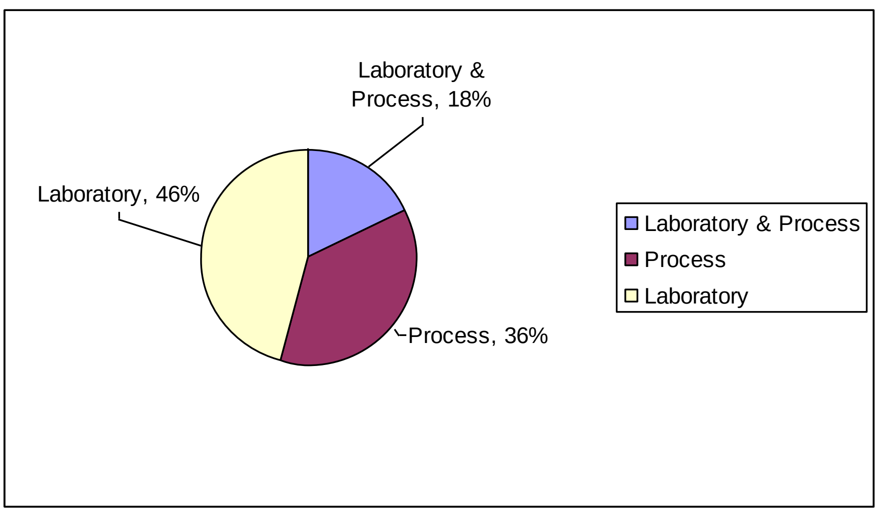

Figure 9: Percentage of types of participating CBTT programs.

The survey questionnaire also requested program participants to characterize the future demand for chemistry-based technicians from their program. Of the responding program participants, 60% indicated a high demand for technicians, 27% a moderate demand, 4% a low demand, and 8% of the participants responded as being uncertain of the demand for their trained technicians, see Figure 10.

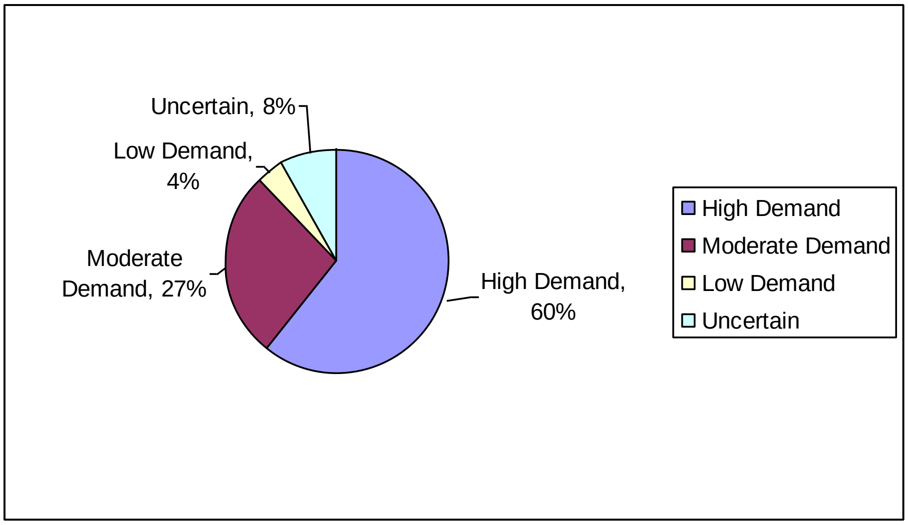

Figure 10: Future demand for chemistry-based technicians.

Awareness of a community's job market needs is an important aspect of education and training in community colleges. An incomplete understanding of the current and future local job market may be detrimental not only to the college but also for students looking for work after the educational program ends. One of the current study's research questions was designed to determine the relative importance of the four clustered categories of factors associated with CBTT program sustainability to assist in trying to meet the current and future demands for well-trained technicians.

Research Question One

This section of the study addresses the first research question: What is the relative importance of the identified factors relating to the economic sustainability of CBTT programs? The answer to this question was restricted to an evaluation of the rankings of the four clustered categories of sub-factors identified in the literature review. In the literature review of professional technical training programs, this researcher found that very little information was available for educators with regard to CBTT program sustainability. The two major contributors to the review of literature on this subject were the PACT and ChemTechLinks reports. However, information outside the scope of these studies was required to understand the full impact of the factors related to CBTT program sustainability. Using the review of literature as a basis, the most frequently represented characteristics of professional technical training programs, as they relate to CBTT program sustainability, were selected to investigate. The characteristics, known as sub-factors in the current study, were clustered into four major categories: Partnerships, Employer and Student Educational Goals, Faculty and Their Resources, and Community Perceptions and Marketing. The survey asked participants to rank the order of importance of each of the clustered categories to CBTT program sustainability. Respondents ranked the importance of each of the clustered categories from 1 to 4, with 4 being the highest. There were six participants who did not rank the clustered categories. To determine the relative importance of the clustered categories to sustainability, the rankings of all participants were examined. The frequency distributions and rankings of all CBTT program participants are summarized in Appendix E. The use of all participants' data was deemed appropriate by this researcher after an in-depth analysis of the data from specific programs having both faculty and administrator respondents, see Appendix L. The statistical analyses documented in Appendix L yielded very similar results to those from all participant data. The comparison using all participants' data allowed this researcher to analyze data with a greater sample size.

Further descriptive statistics, in the form of clustered category ranking means and the associated standard deviations, are provided in Table 9. The data collected from all the respondents produced an ordered ranking of importance to sustainability to be: Partnerships, Employer and Student Educational Goals, Faculty and Their Resources, and Community Perceptions and Marketing Strategies.

Table 9: *Summary of Mean Rankings of All CBTT Program Participants of the Clustered Categories Relating to Sustainability*

Clustered Category			Mean	SD
Partnerships			2.82	1.11
Employer and Student Educational Goals			2.63	1.08
Faculty and Their Resources			2.53	0.96
Community Perceptions and Marketing Strategy			2.02	1.18
N	Valid	89		
	Missing	6		

Respondents' data were separated into small and large program participants. Although small program participants still ranked the clustered category of Partnerships highest, Faculty and Their Resources was ranked as having a greater importance than Employer and Student Educational Goals, see Table 10. In addition, the mean ranking of Community Perceptions and Marketing Strategy was somewhat higher for participants of small programs than the overall participants' mean ranking. Large program data provided an ordered ranking of importance to sustainability to be: Partnerships and Employer and Student Educational Goals were equally ranked in degree of importance to program sustainability, followed by Faculty and Their Resources and Community Perceptions and Marketing Strategy, see Table 10.

Table 10: *Summary of Mean Rankings of Small and Large CBTT Program Participants of the Importance of the Clustered Categories Relating to Sustainability*

Clustered Category	Small Program Participants Mean	Small Program Participants SD	Large Program Participants Mean	Large Program Participants SD
Partnerships	2.74	1.05	2.90	1.19
Faculty and Their Resources	2.55	1.08	2.50	0.80
Employer and Student Educational Goals	2.38	1.03	2.90	1.08
Community Perceptions and Marketing Strategy	2.32	1.29	1.69	0.95

		Small Program Participants	Large Program Participants
N	Valid	47	42
	Missing	3	3

Differences in the rankings of clustered category importance by small and large program participants were statistically analyzed further using the Mann-Whitney U test of significance, hereafter referred to as Mann-Whitney. The null hypothesis (H_o) was that there were no significant differences in ratings between large and small program participants of the sub-factors relating to program sustainability. The alternative hypothesis (H_1) was that significant differences were indicated. The results of this test of significance are presented in Table 11. At the 0.05 level of confidence, there were significant differences in the opinions of small and large program participants with regard to the rankings of two of the clustered categories, Employer and Student Goals and Community Perceptions and Marketing Strategies.

Table 11: *Mann-Whitney Test of Significant Differences in Rankings of Small and Large Program Participants as to the Importance of Clustered Categories Relating to Sustainability*

Clustered Category	Z-Value	Significance (2-tailed)
Community Perceptions and Marketing Strategy	-2.37	0.02*
Employer and Student Educational Goals	-2.32	0.02*
Partnerships	-0.79	0.43
Faculty and Their Resources	-0.31	0.76

* Significance at the 0.05 level (2-tailed)

N	Valid	47 Small Program Participants
		42 Large Program Participants
	Missing	6

In summary, differences of opinions in the ranked orders of the clustered categories by the participants of large and small programs imply that each may have different needs regarding their approach to sustainability. For example, one small program participant commented:

> We are sustainable however there are other factors that the college is concerned about. With the California State budget being in bad shape, all small and low enrollment programs are being evaluated. I have been encouraged by my Division Dean that our program is OK. However, I am concerned about future college funding for programs with small student numbers. (Survey Response to Part IV)

Another small program participant made additional comments with respect to their ranking of the four categories, saying,

> In answering the survey it occurs to me that through the years the influence and contributions of various stakeholders has [*sic*] been inconsistent. For example…I rank the “Community Perception and Marketing

> Strategy" second only to the "Faculty and Their Resources" because our other areas are currently strong…. (Survey Response to Part IV)

The category, Community Perceptions and Marketing Strategies, was ranked as the lowest factor of importance in each of the three groups (all, small, and large participants). However, large program participant data had a much lower mean than did small program participants for this category. This may be due to large programs not having to be as concerned with community perception and marketing as do small programs. One large program respondent stated that having a greater number of students enrolled provides "word-of-mouth" as a valuable marketing tool (Survey Response to Part IV). However, several small program participants cited issues related to community perceptions and marketing strategies affecting their program's sustainability. One participant went so far as to say "…marketing is my biggest single challenge" (Survey Response to Part IV). Another participant pointed out the need for a "better image for CBTT programs" as an important factor related to program sustainability (Survey Response to Part IV). Further commentary stated:

> This program needs the resources to make our program and its opportunities known to High School and young college age students. Marketing is an ongoing struggle. The need by industry continues to grow and we have few students to meet the demand." (Survey Response to Part IV)

Figure 11 illustrates comparisons between the perspective rankings from all CBTT program participants of the relative importance of each of the clustered categories related to program sustainability. In addition, comparisons of rankings of the clustered categories to program sustainability by small and large program participants are provided.

Ordered Ranking	All Program Participants	Small Program Participants	Large Program Participants
Most Important	Partnerships	Partnerships	Partnerships
	Employer & Student Goals	Faculty & Their Resources	Employer & Student Goals
	Faculty & Their Resources	Employer & Student Goals	Faculty & Their Resources
Least Important	Community Perceptions & Marketing Strategies	Community Perceptions & Marketing Strategies	Community Perceptions & Marketing Strategies

Figure 11: Summary of ranked orders of the clustered categories pertaining to CBTT program sustainability.

Research Question Two

This section of the study addresses the second research question: What differences exist between the opinions of administrators and faculty with regard to the factors associated with CBTT program sustainability? This section of the current study will address the faculty and administrator differences in the ranked order of importance of each of the clustered categories. Differences in rankings were analyzed and discussed from the results of the Mann-Whitney test of significant differences. Comparisons of ranking means and standard deviations are also presented. Furthermore, analyses of differences of opinions of administrators and faculty regarding the ratings of the sub-factors as they relate to program sustainability is also presented in this section. The Mann-Whitney test was used to determine significant differences in the overall opinions with respect to the ratings of each of the sub-factors for not only faculty and administrators, but also for small and large program participants. Finally, MANOVA was used to identify and distinguish between the differences in the opinions of the ratings of the sub-factors of large program faculty, large program administrators, small program faculty and small program administrators. The use of all participants' data was deemed appropriate by this researcher after an in-depth analysis of the data from faculty and administrators from related programs were evaluated, see Appendix L.

Clustered Category Rankings of Faculty and Administrators

Respondents ranked the importance of each of the clustered categories from 1 to 4, with 4 being the highest. Six of the participants elected not to rank the clustered categories, four faculty and two administrators. To determine the relative importance of the clustered categories to sustainability, the rankings of faculty and administrators were examined separately. The frequency distributions and rankings of faculty and administrators are summarized in Appendix E.

The data collected from CBTT program administrators gave the following ordered ranking of importance to sustainability: Partnerships, Faculty and Their Resources, Employer and Student Educational Goals, and Community Perceptions and Marketing Strategies, see Table 12. Faculty ranked the clustered categories with respect to the importance to sustainability as being Partnerships, Employer and Student Goals, Faculty and Their Resources, and Community Perceptions and Marketing Strategies. Both faculty and administrators ranked partnerships as the most important category and community perceptions and marketing strategies as the least important category of sub-factors associated with program sustainability. Although the faculty ordered ranking of importance was similar to that of administrators, the differences in the means of the importance of each clustered category had broader ranges for faculty than for administrators. In addition, analysis of the mean rankings of the clustered categories indicated that faculty, as contrasted with administrators, felt Employer and Student Educational Goals were more important than Faculty and Their Resources.

Table 12: *Summary of Mean Rankings of CBTT Program Administrators and Faculty of the Relative Importance of the Clustered Categories Relating to Sustainability*

	Administrators		Faculty	
Clustered Category	Mean	SD	Mean	SD
Partnerships	2.81	1.21	2.82	1.08
Faculty and Their Resources	2.48	0.98	2.55	0.95
Employer and Student Educational Goals	2.41	1.01	2.73	1.10
Community Perceptions and Marketing Strategy	2.30	1.27	1.90	1.13

		Administrators	Faculty
N	Valid	27	62
	Missing	2	4

The differences in rankings of the four clustered categories by program faculty and administrators were statistically analyzed using the Mann-Whitney test. The results are presented in Table 13. At the 0.05 level of confidence, there were no statistically significant differences in the rankings by program faculty and administrators regarding the importance of the four clustered categories.

Table 13: *Mann-Whitney Test of Significant Differences in Rankings by Administrators and Faculty as to the Importance of the Clustered Categories Relating to Program Sustainability*

Clustered Category	Z-Value	Sig.
Partnerships	-0.01	0.99
Employer and Student Educational Goals	-1.35	0.18
Faculty and Their Resources	-0.40	0.69
Community Perceptions and Marketing Strategy	-1.38	0.17

** Significant at the 0.01 level
* Significant at the 0.05 level

N	Valid	62	Faculty Participants
		27	Administrator Participants
	Missing	6	

Clustered Category Sub-Factor Ratings of Faculty and Administrators

This researcher used the Mann-Whitney test of significance to determine whether or not there were statistically different ratings by faculty and administrator program participants concerning the sub-factors relating to program sustainability. The Mann-Whitney test of significance was deemed appropriate in order to compare the ratings of the two unequal sample sized groups having non-parametric rating distributions. This test was used to compare differences in the distributions associated with the 31 Likert scale statements in the survey. The null hypothesis (H_o) was that there were no significant differences in ratings between administrator and faculty participants of the sub-factors relating to program sustainability. The alternative hypothesis (H_1) was that significant differences were indicated. A summary of the results for each of the sub-factor ratings is presented in Table 14.

Table 14: *Mann-Whitney Tests of Significant Differences in Ratings of Program Sustainability and the Sub-Factors by Program Administrators and Faculty*

Variables	Faculty Mean	Faculty SD	Administrators Mean	Administrators SD	Z-Value	Sig.
Sustainability	3.94	0.91	4.00	1.13	-0.76	0.45
Degree of Partnering	4.06	1.01	4.17	1.04	-0.76	0.45
Responsiveness to Industry’s Training Needs	4.44	0.70	4.31	0.89	-0.44	0.66
Administration’s Promotion of Partnerships	3.80	1.13	4.17	0.85	-1.36	0.17
President’s Involvement in Partnerships	3.70	1.07	4.03	0.73	-1.31	0.19
Education and Training Philosophy Differences	3.79	0.83	3.79	0.86	-0.19	0.85
Administrative Style Differences	3.65	1.00	3.69	0.76	-0.14	0.89
Ethical Differences	3.94	0.89	3.97	0.78	-0.11	0.91
Experiential Learning Opportunities	4.02	0.97	3.93	1.03	-0.32	0.75
Employer Input in Curriculum Development	4.17	0.80	4.48	0.79	-2.10	0.04*
Job Skill Standards	3.88	1.02	4.24	0.91	-1.79	0.07
ACS Skill Standards	2.97	1.25	3.21	1.21	-0.81	0.42
Employability Skills	4.35	0.81	4.34	0.72	-0.25	0.81
Number of Program Graduates	4.02	0.95	4.31	0.66	-1.30	0.19
Hiring Practices of Non-graduates	3.45	1.04	3.38	0.94	-0.28	0.78
Degree of Student Job Placement	4.02	1.02	4.07	0.92	-0.14	0.89
Transferability of Program Credits	3.44	1.25	3.28	1.31	-0.55	0.58
Obtaining and Retaining Faculty	3.44	1.25	3.28	1.25	-0.60	0.55
Quality of Instruction and Use of Part-time Faculty	3.49	1.12	3.52	1.02	-0.03	0.97
Faculty Professional Development Opportunities	3.26	1.10	3.24	1.02	-0.28	0.78
Excessive Faculty Workloads	3.18	1.12	2.28	0.80	-3.72	0.00**
Equipment and Instrumentation Funding	3.20	1.33	3.34	1.14	-0.37	0.71
Classroom and Laboratory Funding	3.35	1.23	3.55	1.15	-0.72	0.47
Funding from Outside Sources	3.85	1.01	4.10	0.82	-1.12	0.26
Faculty Position Funding	3.00	1.05	3.41	1.02	-1.91	0.06
Administration Emotional Support	3.20	1.06	3.66	0.97	-1.77	0.08
Presence of a Champion	3.86	0.98	4.14	0.81	-1.41	0.16
Flexible Scheduling of Classes	3.50	0.95	3.83	0.97	-1.50	0.13
Community Visibility of Program	2.88	1.07	3.10	1.29	-0.77	0.44
Positive Perception of the Profession	3.26	0.79	3.55	0.95	-1.38	0.17
College Marketing Plan	2.45	1.07	2.66	0.97	-0.89	0.38
Program Promotion to Secondary Students	2.85	1.22	3.07	1.25	-0.82	0.41

** Significant at the 0.01 level (2-tailed)
*   Significant at the 0.05 level (2-tailed)

N = 95   (29 Administrators and 66 Faculty)

There was no significant difference in the ratings of program sustainability by administrator and faculty participants. Only two of the 31 clustered category sub-factors displayed significantly different ratings across the entire set of survey items: the extent of employer input in curriculum development and the effect of excessive faculty workloads as they relate to their program's sustainability. The differences in opinions regarding employer input in curriculum development appear to be related to the magnitude of agreement between faculty and administrators. Thirty-six percent of the faculty participants strongly agreed and 49% agreed that their CBTT programs had a considerable amount of employer input in the curriculum development in comparison with the administrator's perspective in which 62% strongly agreed and 28% agreed, see Appendix F. Administrators were of the opinion that there was a higher degree of employer input in CBTT curriculum development as compared with faculty. There was a significant difference between the ratings of the two groups regarding faculty workloads; 46% of the faculty participants indicated excessive workloads had affected their program's sustainability, whereas only 10% of the administrator participants agreed. More faculty participants felt that excessive faculty workloads had affected their program's sustainability than did administrator participants.

Differences in Ratings of the Sub-Factors by Large and Small Program Participants

As pointed out in an earlier discussion of the current study, this researcher observed differences in the responses of participants in large and small programs with respect to the rankings of importance of each of the four clustered categories, as well as ratings of the sub-factors. Therefore the current research further investigated differences in the sub-factor ratings of all large and small program participants. A small program was defined as one that had less than 35 students enrolled and a large program was one that had 35 or more students enrolled. The null hypothesis (H_o) was that there were no significant differences in ratings between large and small program participants of the sub-factors relating to program sustainability. The alternative hypothesis (H_1) was that significant differences were indicated.

This researcher elected to use the Mann-Whitney test to determine whether or not there were significant differences in the ratings of the sub-factors associated with program sustainability between two groups: large program participants and small program participants. The Mann-Whitney test of significance was deemed appropriate in order to compare the ratings of two groups of unequal sample sizes and non-parametric rating distributions. This test was used to compare differences in the distributions associated with the 31 Likert scale statements in the survey. A summary of the results for each of sub-factors is presented in Table 15.

Table 15: *Mann-Whitney Tests of Differences in Ratings of Program Sustainability and the Sub-Factors by Small and Large Program Participants*

Variables	Small Program Participants Mean	SD	Large Program Participants Mean	SD	Z-Value	Sig.
Sustainability	3.48	1.01	4.49	0.59	-5.17	0.00**
Degree of Partnering	3.80	1.11	4.42	0.78	-3.06	0.00**
Responsiveness to Industry's Training Needs	4.38	0.73	4.42	0.81	-0.58	0.56
Administration's Promotion of Partnerships	3.68	1.19	4.18	0.83	-2.01	0.05*
President's Involvement in Partnerships	3.62	1.10	4.00	0.80	-1.48	0.14
Education and Training Philosophy Differences	3.86	0.88	3.71	0.79	-0.80	0.43
Administrative Style Differences	3.76	1.02	3.56	0.81	-1.22	0.22
Ethical Differences	4.00	0.90	3.89	0.80	-0.73	0.47
Experiential Learning Opportunities	3.90	1.05	4.09	0.90	-0.75	0.48
Employer Input in Curriculum Development	4.14	0.88	4.40	0.69	-1.37	0.17
Job Skill Standards	3.84	1.00	4.16	0.98	-1.76	0.08
ACS Skill Standards	3.12	1.32	2.96	1.15	-0.59	0.56
Employability Skills	4.34	0.89	4.36	0.65	-0.53	0.59
Number of Program Graduates	3.86	0.99	4.38	0.65	-2.63	0.01**
Hiring Practices of Non-graduates	3.26	1.03	3.62	0.96	-1.85	0.06
Degree of Student Job Placement	3.86	1.11	4.22	0.79	-1.45	0.15
Transferability of Program Credits	3.62	1.21	3.13	1.29	-1.89	0.06
Obtaining and Retaining Faculty	3.58	1.21	3.18	1.27	-1.57	0.12
Quality of Instruction and Use of Part-time Faculty	3.46	1.09	3.55	1.09	-0.31	0.75
Faculty Professional Development Opportunities	3.10	1.17	3.42	0.94	-1.36	0.17
Excessive Faculty Workloads	3.10	1.23	2.69	0.92	-1.65	0.10
Equipment and Instrumentation Funding	3.12	1.35	3.38	1.17	-0.87	0.39
Classroom and Laboratory Funding	3.38	1.16	3.44	1.27	-0.36	0.72
Funding from Outside Sources	3.64	1.06	4.24	0.71	-2.92	0.00**
Faculty Position Funding	3.02	1.15	3.24	0.93	-1.19	0.23
Administration Emotional Support	3.02	1.10	3.69	0.87	-2.94	0.00**
Presence of a Champion	3.76	1.00	4.18	0.81	-2.15	0.03*
Flexible Scheduling of Classes	3.30	0.89	3.93	0.94	-3.40	0.00**
Community Visibility of Program	2.48	1.03	3.47	1.04	-4.25	0.00**
Positive Perception of the Profession	3.02	0.71	3.71	0.84	-4.00	0.00**
College Marketing Plan	2.16	0.98	2.91	1.06	-3.51	0.00**
Program Promotion to Secondary Students	2.56	1.13	3.31	1.22	-2.97	0.00**

** Significant at the 0.01 level (2-tailed)
* Significant at the 0.05 level (2-tailed)

N = 95 (45 large programs and 50 small programs)

In addition to the rating of sustainability, eleven of the 31 sub-factors (35%) displayed significant differences at the 0.05 level of confidence between the ratings of participants from small and large programs. Since this disagreement suggests differences in opinions regarding the factors associated with CBTT program sustainability, this researcher examined the participant data from small programs and large programs separately. Discussions of these differences are included in the analyses of the clustered categories of sub-factors that follow.

Differences in Opinions of Large and Small Program Faculty and Administrators

The Mann-Whitney tests of significance were carried out on the ratings of the sub-factors by all program faculty and administrators as well as between large and small program participants. Analysis of data from the survey indicated that the differences of opinions required a more in-depth analysis of ratings. Therefore, the current study investigated the differences in opinions of faculty and administrators on an even more delineated level. This researcher investigated the differences in the opinions of faculty and administrators by taking into consideration program size and separating the data into large and small program administrators and faculty. Therefore, the opinions of four groups (large program faculty, large program administrators, small program faculty, and small program administrators) were examined with regard to each sub-factor rating in relation to their program's sustainability. This required the use of the statistical technique of Multivariate Analysis of Variance (MANOVA). MANOVA is a statistical technique that allows the researcher to test null hypotheses involving more than one dependent variable.

More specifically, it allowed for the simultaneous testing of one or more independent variables on two or more dependent variables.

The MANOVA procedure generated an F-statistic that was used to determine whether or not a null hypothesis could be rejected at the 0.05 level of confidence. The null hypothesis (H_o) was that there were no significant differences of opinions between faculty and administrators of large and small programs regarding the sub-factors associated with program sustainability. The alternative hypothesis (H_1) was that significant differences were indicated. If there are significant differences between the means of the samples, the F-statistic does not tell you which mean is significantly greater than the other (Vogt, 2007). Tamhane's post hoc test, based on Student's t-distribution, was used to determine, pair-wise, which of the four groups (small program faculty, large program faculty, small program administrators, and large program administrators) displayed significant differences in the ratings of sub-factors. The sample size for each of the four groups is shown in Table 16.

Table 16: *Sample Size for Small and Large Program Faculty and Administrators*

Group	Participants
Small program faculty	39
Small program administrators	11
Large program faculty	27
Large program administrators	18

N = 95

The data were analyzed using the SPSS General Linear Model Multivariate program. The sub-factors of each separate clustered category were entered as dependent variables and the four groups were the "fixed factors," or independent variables. The F-statistics for the multivariate tests were calculated and significance levels reported using Wilks' Lambda. The results of the MANOVA disclosed significant differences among the sub-factors within three of the four clustered categories. A summary of the multivariate analysis results is given in Table 17. The results indicated a rejection of the null hypothesis that there was no significant difference in the opinions of the four groups (subjects) with respect to their ratings of the sub-factors within Employer and Student Educational Goals, Faculty and Their Resources, and Community Perceptions and Marketing Strategies. In addition, the results indicated an acceptance of the null hypothesis that there was no significant difference in the opinions of the four groups (subjects) relative to their ratings of the sub-factors within the clustered category of Partnerships.

Table 17: *Summary of Wilks' Lambda Multivariate Analysis of Variance of Ratings of the Sub-Factors of the Clustered Categories*

Clustered Category	F-statistic	df	Significance
Partnerships	1.20	3, 91	0.24
Employer and Student Educational Goals	1.75	3, 91	0.03*
Faculty and Their Resources	2.04	3, 91	0.00**
Community Perceptions and Marketing Strategies	3.05	3, 91	0.00**

** Significant at the 0.01 level (2-tailed)
* Significant at the 0.05 level (2-tailed)

N = 95

Although Wilks' Lambda provided information with respect to the four clustered categories, it did not indicate which specific sub-factors had significant differences of opinions. The Tests of Between-Subjects Effects, based on the F-statistic, determined significant differences in the sub-factor ratings by the four groups (small program administrators, large program administrators, small program faculty and large program faculty). For the sub-factors within the clustered categories that displayed significant differences at the 0.05 level, multiple comparisons between the four groups were then analyzed using post hoc Tamhane tests to determine which specific groups had significant differences in their ratings of the sub-factors. According to the SPSS Statistics Coach, the Tamhane test for analysis of variance is generally more appropriate for different cell size analyses. Note that because Wilks' Lambda did not indicate statistically significant differences in opinions of the four groups with respect to Partnerships, no further statistical analysis was carried out for this clustered category of sub-factors.

Employer and student educational goals. The Wilks' Lambda multivariate test of overall differences among the four groups was statistically significant for the clustered category of Employer and Student Educational Goals, $F(3, 91) = 1.75$ and $p < 0.05$, see Table 17. Therefore the null hypothesis was rejected, indicating that there were differences in the ratings of the four groups of participants. Univariate between-subjects tests revealed that only one of the sub-factors within this clustered category, the number of students completing the program, had a significant difference of opinion among the four groups, $F(3, 91) = 3.34$, which was significant at the 0.05 level, see Table 18.

Table 18: *Summary of Tests of Between-Subjects Effects for Employer and Student Educational Goals*

Dependent Variable	F-statistic	df	Significance
Number of Program Graduates	3.34	3, 91	0.02*
Hiring of Non-graduates	2.09	3, 91	0.11
Job Skill Standards	2.06	3, 91	0.11
Transferability of Program Credits	1.53	3, 91	0.21
Degree of Student Job Placement	1.08	3, 91	0.36
Employability Skills	0.82	3, 91	0.49
ACS Skill Standards	0.47	3, 91	0.70

** Significant at the 0.01 level (2-tailed)
* Significant at the 0.05 level (2-tailed)

N = 95

Tamhane's post hoc analysis showed the most significant difference, $p < 0.05$, existed between the ratings of small program faculty and large program administrators with regard to the sub-factor, number of program graduates of the CBTT program, see Table 19. Large program administrators considered the number of program graduates more strongly influenced their program's sustainability than did small program faculty.

Table 19: *Summary of Significance Levels of the Tamhane Post Hoc Test for the Sub-Factor Number of Program Graduates*

	Large Program Administrators	Large Program Faculty	Small Program Administrators	Small Program Faculty
Ratings Mean	4.44	4.33	4.09	3.79
Ratings SD	0.51	0.73	0.83	1.03
Small Program Faculty	0.02*	0.09	0.91	-------
Small Program Administrators	0.78	0.96	-------	
Large Program Faculty	0.99	-------		
Large Program Administrators	-------			

N = 95
** Significant at the 0.01 level
* Significant at the 0.05 level

Faculty and their resources. The Wilks' Lambda multivariate test among the four groups and the sub-factors associated with the clustered category, Faculty and Their Resources, indicated there were statistically significant differences, $F(3, 91) = 2.04$, $p < 0.01$, see Table 17. Further investigation using the Tests of Between-Subjects Effects revealed that four of the seven sub-factors in the clustered category resulted in a rejection of the null hypothesis. The univariate between-subjects test showed that differences in the ratings of the four groups were significant for the sub-factors: excessive faculty workloads, flexible scheduling of classes, administration emotional support, and funding from outside sources, see Table 20.

Table 20: *Tests of Between-Subjects Effects for Faculty and Their Resources*

Dependent Variable	F-statistic	df	Significance
Excessive Faculty Workloads	7.51	3, 91	0.00**
Flexible Scheduling of Classes	4.87	3, 91	0.00**
Administration Emotional Support	4.60	3, 91	0.01**
Funding from Outside Sources	3.61	3, 91	0.02*
Obtaining and Retaining Faculty	0.96	3, 91	0.42
Quality of Instruction and Use of Part-time Faculty	0.25	3, 91	0.86
Faculty Professional Development Opportunities	0.79	3, 91	0.50
Presence of a Champion	2.06	3, 91	0.11
Faculty Position Funding	1.34	3, 91	0.27
Equipment and Instrumentation Funding	0.57	3, 91	0.63
Classroom and Laboratory Funding	0.50	3, 91	0.68

** Significant at the 0.01 level (2-tailed)
*   Significant at the 0.05 level (2-tailed)

N = 95

Analysis of the multiple comparisons pointed out the origins of these differences, see Tables 21, 22, 23, and 24. The sub-factor, excessive faculty workloads, showed a significant difference of opinion ($p < 0.01$) between small program faculty and large program administrators, see Table 21. In addition, there was another statistically significant difference in ratings regarding excessive faculty workloads ($p < 0.01$) between faculty and administrators of small programs. Based on the rating means, small program faculty felt excessive faculty workloads had more of an effect on their CBTT program's sustainability. Small and large program administrators indicated that their program's sustainability was not being affected by excessive faculty workloads. Interestingly, as opposed to small program faculty and administrators, large program faculty and administrators indicated no significant difference of opinion regarding faculty workload issues related to program sustainability.

Table 21: *Summary of Significance Levels of the Tamhane Post Hoc Test for the Sub-Factor Excessive Faculty Workloads*

	Large Program Administrators	Large Program Faculty	Small Program Administrators	Small Program Faculty
Ratings Mean	2.44	2.85	2.00	3.41
Ratings SD	0.78	0.99	0.77	1.16
Small Program Faculty	0.00**	0.16	0.00**	-------
Small Program Administrators	0.62	0.08	-------	
Large Program Faculty	0.70	-------		
Large Program Administrators	-------			

** Significant at the 0.01 level
* Significant at the 0.05 level

N = 95

The presence of flexible scheduling of classes related to program sustainability in improved educational opportunities for students showed a significant difference, $F(3, 91) = 4.87$, $p < 0.01$, in the ratings of the four groups, see Table 20. Significant differences of opinions were observed between two pairs of groups: small program faculty and large program administrators ($p < 0.01$), as well as between small and large program administrators ($p < 0.05$), see Table 22. Both faculty and administrators from small programs rated the presence of flexible scheduling as having resulted in improved educational opportunities for CBTT students lower than did large program administrators. Participants of small programs did not show significant disagreements, nor did large program participants. These agreements suggest that opinions regarding flexible scheduling, as it relates to program sustainability, may be program size dependent.

Table 22: *Summary of Significance Levels of the Tamhane Post Hoc Test for the Sub-Factor Flexible Scheduling of Classes*

	Large Program Administrators	Large Program Faculty	Small Program Administrators	Small Program Faculty
Ratings Mean	4.22	3.74	3.18	3.33
Ratings SD	0.81	0.98	0.87	0.90
Small Program Faculty	0.00**	0.50	1.00	-------
Small Program Administrators	0.03*	0.50	-------	
Large Program Faculty	0.39	-------		
Large Program Administrators	-------			

N = 95
** Significant at the 0.01 level
* Significant at the 0.05 level

The survey item regarding administration emotional support showed significant differences in the ratings of the four groups, $F(3, 91) = 4.60$, $p < 0.05$, see Table 20. Perception differences between faculty and administration were supported by the Tamhane post hoc test. The results showed the most significant difference in the ratings ($p < 0.05$) was between large program administrators and small program faculty, see Table 23. Large program administrators indicated college administrators had strongly supported their program instructors through encouragement in morale building and job satisfaction. However, small program faculty were not of the same opinion, suggesting a need for additional administrator involvement in providing emotional support. Interestingly, large program administrators and faculty did not indicate a significant disagreement between each other, nor did small program faculty and administrators. These agreements may be an indication that program size is more significant than academic position regarding administrative emotional support associated with CBTT program sustainability.

Table 23: *Summary of Significance Levels of the Tamhane Post Hoc Test for the Sub-Factor Administration Emotional Support*

	Large Program Administrators	Large Program Faculty	Small Program Administrators	Small Program Faculty
Ratings Mean	4.00	3.48	3.09	3.00
Ratings SD	0.84	0.85	0.94	1.15
Small Program Faculty	0.02*	0.91	0.914	-------
Small Program Administrators	0.78	0.96	-------	
Large Program Faculty	0.99	-------		
Large Program Administrators	-------			

N = 95
** Significant at the 0.01 level
* Significant at the 0.05 level

The survey item concerning continued support from outside funding showed significant differences in the ratings of the four groups, $F(3, 91) = 3.61$, $p < 0.05$, see Table 20. For this sub-factor the multiple comparisons post hoc test revealed the most significant difference in opinions existed between large program administrators and small program faculty, see Table 24. In this case, the ratings of large program administrators indicated that funding and other resources, including instrumentation and equipment provided by sources outside of the college, had continued to support their program's sustainability. However, small program faculty indicated less support from sources outside the college to maintain their program sustainability.

Table 24: *Summary of Significance Levels of the Tamhane Post Hoc Test for the Sub-Factor Funding and Other Resources from Outside the College*

	Large Program Administrators	Large Program Faculty	Small Program Administrators	Small Program Faculty
Ratings Mean	4.39	4.15	3.64	3.64
Ratings SD	0.50	0.82	1.03	1.09
Small Program Faculty	0.01**	0.20	1.00	-------
Small Program Administrators	0.22	0.65	-------	
Large Program Faculty	0.82	-------		
Large Program Administrators	-------			

** Significant at the 0.01 level
*   Significant at the 0.05 level

N = 95

Community perceptions and marketing strategies. The Wilks' Lambda multivariate test of overall differences among the four groups involving the sub-factors associated with the clustered category Community Perceptions and Marketing Strategies was statistically significant, $F(3, 91) = 3.05$, $p < 0.01$, see Table 17. The results indicated significant differences in the ratings between the four groups with regard to the sub-factors associated with Community Perceptions and Marketing Strategies. Further investigation using the univariate between-subjects test showed that differences in the ratings of the four groups were significant for the sub-factors, community visibility of the program, positive perception of the profession, a college marketing plan, and program promotion to secondary students, see Table 25.

Table 25: *Tests of Between-Subjects Effects for Community Perception and Marketing*

Dependent Variable	F-statistic	df	Significance
Community Visibility of Program	9.47	3, 91	0.00**
Positive Perception of the Profession	6.73	3, 91	0.00**
College Marketing Plan	4.71	3, 91	0.00**
Program Promotion to Secondary Students	3.48	3, 91	0.02*

** Significant at the 0.01 level
* Significant at the 0.05 level

The survey item concerning community visibility of the CBTT program indicated significant differences in the ratings of the four groups, $F(3, 91) = 9.47$, $p < 0.01$, see Table 25. For this sub-factor the multiple comparisons post hoc test revealed the opinions of large program administrators and small program faculty differed with regard to community visibility of the CBTT program ($p < 0.01$), see Table 26. Large program administrators rated their program's visibility to prospective students in the community higher than small program faculty. Adding further insight into differences in perspectives, large program faculty and small program administrators also differed significantly ($p < 0.01$) regarding community visibility of the program. Large program faculty rated their program's community visibility higher than small program administrators. Finally, large and small program administrators did not agree about their program's visibility within their local communities ($p < 0.01$). Large program administrators rated the community visibility of their program higher than small program administrators. This provides further evidence as to the differences in characteristics that may arise primarily due to the size of the program.

Table 26: *Summary of Significance Levels of the Tamhane Post Hoc Test for the Sub-Factor Community Visibility of the Program*

	Large Program Administrators	Large Program Faculty	Small Program Administrators	Small Program Faculty
Ratings Mean	3.78	3.26	2.00	2.62
Ratings SD	1.11	0.94	0.63	1.09
Small Program Faculty	0.01**	0.08	0.14	-------
Small Program Administrators	0.00**	0.00**	-------	
Large Program Faculty	0.52	-------		
Large Program Administrators	-------			

N = 95
** Significant at the 0.01 level
* Significant at the 0.05 level

The survey item regarding the presence of a positive community perception of the chemistry-based technician's profession indicated significant differences in the ratings of the four groups, $F(3, 91) = 6.73$, $p < 0.01$, see Table 25. Evidence of differences in the ratings of faculty and administration was supported by the Tamhane post hoc results which showed that there were significant differences in the ratings between large program administrators and small program faculty ($p < 0.01$), see Table 27. The ratings of large program administrators indicated their community's perception of the chemistry-based technician profession was more positive than did small program faculty ratings. In addition, large and small program faculty were also in disagreement ($p < 0.05$) regarding the perception, see Table 27. Large program faculty rated their community's perception of the profession higher than did small program faculty. These differences of opinions provide evidence of the variation in the local communities surrounding large and small CBTT programs.

Table 27: Summary of Significance Levels of the Tamhane Post Hoc Test for the Sub-Factor Community Perceptions of the Profession

	Large Program Administrators	Large Program Faculty	Small Program Administrators	Small Program Faculty
Ratings Mean	3.89	3.59	3.00	3.03
Ratings SD	0.90	0.80	0.77	0.71
Small Program Faculty	0.01*	0.03*	1.00	-------
Small Program Administrators	0.06	0.25	-------	
Large Program Faculty	0.84	-------		
Large Program Administrators	-------			

N = 95
** Significant at the 0.01 level
*   Significant at the 0.05 level

The sub-factor relating a college marketing plan's contribution to the enrollments of students showed a significant difference of opinion, F(3, 91) = 4.71, p < 0.01 in the ratings of the four groups, see Table 25. Significant differences were observed between one pair of the groups, small program faculty and large program administrators (p <0.05), see Table 28. Small program faculty indicated their college's marketing plan contributed less to the enrollment of students in their CBTT programs than did large program administrators.

Table 28: *Summary of Significance Levels of the Tamhane Post Hoc Test for the Sub-Factor College Marketing Plan*

	Large Program Administrators	Large Program Faculty	Small Program Administrators	Small Program Faculty
Ratings Mean	3.00	2.85	2.09	2.18
Ratings SD	0.91	1.17	0.83	0.91
Small Program Faculty	0.02*	0.09	1.00	-------
Small Program Administrators	0.07	0.18	-------	
Large Program Faculty	1.00	-------		
Large Program Administrators	-------			

N = 95
** Significant at the 0.01 level
* Significant at the 0.05 level

Finally, the survey item pertaining to program promotion to secondary students indicated significant differences in the ratings of the four groups, $F(3, 91) = 3.48$, $p < 0.05$, see Table 25. The Tamhane post hoc results indicated a significant difference in the ratings between small and large program faculty ($p < 0.05$), see Table 29. Small program faculty rated their college's promotion of their CBTT program to local secondary school students lower than large program faculty. These differences in ratings between large and small program participants lend support to the concern that promotion and marketing should be further investigated with respect to program size.

Table 29: *Summary of Significance Levels of the Tamhane Post Hoc Test for the Sub-Factor Program Promotion to Secondary Students*

	Large Program Administrators	Large Program Faculty	Small Program Administrators	Small Program Faculty
Ratings Mean	3.22	3.37	2.82	2.49
Ratings SD	1.35	1.15	1.08	1.14
Small Program Faculty	0.29	0.02*	0.947	-------
Small Program Administrators	0.945	0.67	-------	
Large Program Faculty	1.00	-------		
Large Program Administrators	-------			

N = 95
** Significant at the 0.01 level
*   Significant at the 0.05 level

Summary. MANOVA was used to test the null hypotheses that there were no significant differences between the ratings of four separate groups of participants regarding the sub-factors in each of the four clustered categories: Partnerships, Employer and Student Educational Goals, Faculty and Their Resources, and Community Perceptions and Marketing Strategies. The four groups consisted of small program faculty, small program administrators, large program faculty, and large program administrators.

The current study determined that there were significant differences among the opinions of the four groups regarding the sub-factors of three of the clustered categories. Of the four clustered categories, only Partnerships did not display a significant difference in ratings at the 0.05 confidence level. Tests of between-subjects effects revealed significant differences in the opinions of the groups of participants for eight of the sub-factors.

Tamhane's post hoc tests of multiple comparisons provided evidence of 14 pairs of significant differences in the four groups' ratings of the 31 sub-factors related to CBTT program sustainability. The majority of the statistically different opinions of participants were related to program size. Thirteen of the 14 differences of opinions occurred between large and small program participants, with nine of these involving differences between administrators and faculty.

Small program faculty ratings were involved in 11 of the significant differences of opinions. Large program administrator ratings were involved in ten of the significant differences of opinions, and in each case except the question concerning excessive faculty workloads, this group rated the sub-factor of concern higher.

There were nine sub-factor ratings related to program sustainability that indicated significant differences of opinion between faculty and administrators in different sized programs: (a) number of program graduates, (b) faculty workloads, (c) funding and other resources from outside sources, (d) administration emotional support, (e) flexible scheduling of classes, (f) community visibility of the program, (g) community perception of the profession, (h) college marketing plans, and (i) program promotion to secondary students. Administrators rated each of the sub-factors higher than faculty with the exception of faculty workloads. There was only one significant difference of opinion not associated with program size differences. This difference of opinion existed between small program faculty and small program administrators and was related to the effect of excessive faculty workloads on program sustainability. Administrators of small programs felt that program sustainability was not affected by excessive faculty workloads. However, faculty of small programs felt that excessive faculty workloads were affecting their program's sustainability.

Research Question Three

This section of the study addresses the third research question: What are the interrelationships among the factors related to the economic sustainability of CBTT programs? In attempting to analyze the factors associated with CBTT program sustainability, this researcher organized the data so that multiple interpretations were possible. Examination and analysis of the data indicated there were significant differences in the opinions of participants based on program size; therefore this researcher separated the data of small program participants from that of large programs for further analysis of the survey responses. Quantitative data are presented and analyzed using descriptive, associational, and inferential statistics, followed by an interpretation of the results. The qualitative data were organized by relevance to each of the sub-factors and are included in the appropriate discussion. By analyzing the individual open-ended statements of respondents, it was possible to discern the links to the relevant independent variables.

The following sections include data analysis of program sustainability ratings, correlations between the ratings of program sustainability and the sub-factors, discussions of the frequency distributions of the 31 Likert scale ratings of the sub-factors associated with program sustainability, and a multiple regression analysis of the sub-factors.

Participant Ratings of Program Sustainability

The following section presents a discussion of the participants' survey ratings of sustainability, including a comparison of small and large program participants. In addition, qualitative information from the survey's open-ended question, including quotes of participants is presented.

Participants were asked to consider and indicate the degree of agreement with the statement: *The chemistry-based technology training program at our college is highly sustainable.* The results of the collected data (see Appendix G) are summarized in Figure 12, where the number 5 corresponds to strongly agree, 4 is agree, 3 is neither agree nor disagree, 2 is disagree and 1 is strongly disagree. Of the participants, 32% strongly agreed their programs were sustainable, 44% agreed, 15% neither agreed nor disagreed, 7% disagreed, and 2% strongly disagreed. The degree of agreement with this statement ascertained a participant's program sustainability rating which was used in correlational analysis with the clustered category sub-factors.

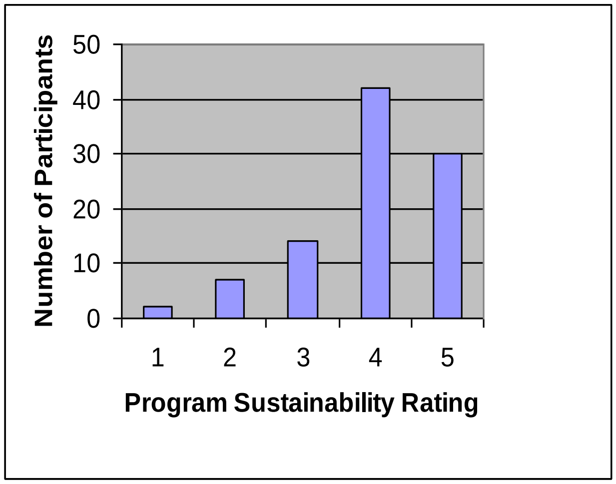

Figure 12: Summary of participants' sustainability ratings of their CBTT programs.

As mentioned in an earlier discussion, the ratings of large and small program participants indicated a significant difference of opinion regarding the sustainability of their CBTT program, see Table 15. When this researcher investigated the data related to the sustainability ratings of small and large programs, 58% of the small program participants indicated some degree of sustainability as compared with 86% of large program participants (See Appendix G). In addition, there were no large program participants that indicated a low degree of sustainability, compared to 18% of small program participant ratings, see Figure 13.

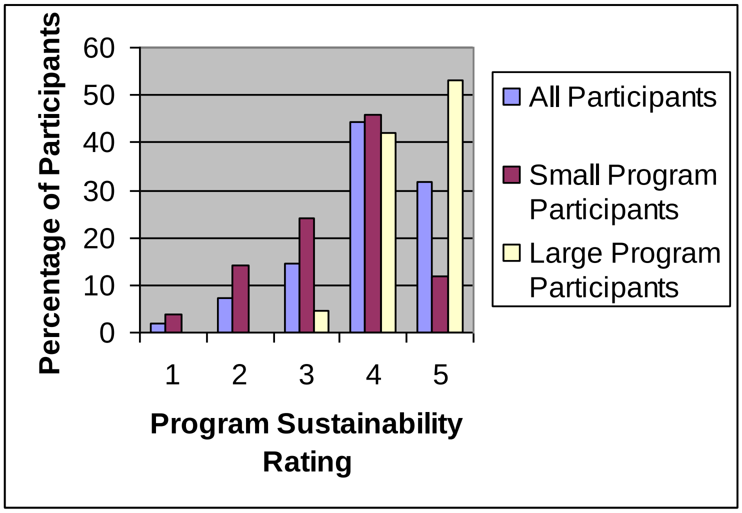

Figure 13: Summary of program sustainability ratings showing all participants, small program participants, and large program participants.

Further insight into program sustainability was obtained from the open-ended question in the survey. The responses revealed that sustainability is influenced by a variety of factors. Regarding program sustainability one participant said:

> Another factor that plays a role in sustainability is whether or not the …Department of Labor designates a program as a "high priority program." This refers to the fact that their research shows that there is a definite need for future employees in this area. (Survey Response to Part IV)

Another program participant said "One of the most important factors for sustainability is the presence of a local job market. Students at 2-year institutions generally tend to be bound to the area and will confine themselves to that region" (Survey Response to Part IV). Reaffirmation of this comment came from a program participant from a non-sustainable program who pointed out their state had lost a significant number of chemical plants and that "At this point in time we are closing our program. The number of graduates has declined and the job market is not what it was in the past" (Survey Response to Part IV). Another relevant comment from a program participant in reference to program sustainability was:

> The current trend in industry is to employ B.S. students and not A.S. technicians, so many end up working for temp agency's [*sic*] in industry. Many need to get their B.S., but industry is not prepared to provide them with time nor money to do so. Most industry leaders want B.S. students and above, the sustainability of the program looks bleak. (Survey Response to Part IV)

In acknowledgement of this opinion another respondent having a two-year CBTT program at a four-year college said:

> Employers are keen to have BS grads, but it seems to me the sustain-ability of the program is at risk if we do not respond to the added-value our students receive from INDUSTRY, and more appropriately step up the level of learning & lab skills experiences and learning/lab goals we set for our students to keep them competitive…. (Survey Response to Part IV)

Colleges with CBTT programs must not only focus on meeting the needs of business and industry but also need to consider many other factors related to sustainability, including development of partnerships, student goals, faculty resources, program funding, community perceptions, and marketing plans. Through a survey of program participants, the current study identified and evaluated responses to 31 survey statements regarding sub-factors that are related to program sustainability. The ratings of these sub-factors were analyzed using a variety of statistical procedures including comparing the opinions of large and small program participants. Insight into the strength of association between the identified sub-factors and a program's sustainability was gained through correlational analysis.

Correlational Analysis of the Sub-Factors Associated With Sustainability

From the review of literature four clustered categories relating to CBTT program sustainability were constructed: Partnerships, Employer and Student Educational Goals, Faculty and Their Resources, and Community Perceptions and Marketing. Each clustered category consisted of sub-factors that were identified as variables influencing program sustainability. These sub-factors were investigated through an analysis of the responses from the current study's survey. Correlational statistics were used to analyze the data collected from the 31 Likert scale statements of the survey (see Appendix A) as they related to CBTT program sustainability. The Pearson coefficient (r) was used as a measure of the correlation between the ratings of the dependent variable (sustainability) and the ratings of each of the independent variables (sub-factors). Significance was set at the $p = 0.05$ confidence level. It is important to remember that the correlation coefficients act as descriptors of what relationship may exist and not what might have made the situation exist. Also included in this section are participant comments that relate to each of the sub-factors that were significantly correlated with program sustainability.

Partnerships. The degrees of relationship between program sustainability and each of the nine sub-factors in the clustered category of Partnerships were determined through correlational statistics. A summary of the results is presented in Table 30.

Table 30: *Rating Correlations of the Partnership Sub-Factors with Program Sustainability*

Independent Variables	Pearson Coefficient	Significance
Degree of Partnering	0.57	0.00 **
Employer Input in Curriculum Development	0.39	0.00 **
Experiential Learning Opportunities	0.33	0.00 **
Responsiveness to Industry's Training Needs	0.27	0.01 **
Administration's Promotion of Partnerships	0.26	0.01 **
President's Involvement in Partnerships	0.25	0.02 *
Administrative Style Differences	-0.17	0.10
Ethical Differences	-0.10	0.31
Education and Training Philosophy Differences	-0.08	0.46

N = 95

** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

The results of the statistical analysis show that the degree of partnerships with business and industry, employer input in curriculum development, experiential learning opportunities, college responsiveness, administration's promotion of partnerships, and a president's involvement in partnerships have statistically significant relationships to CBTT program sustainability. Differences in administrative styles, ethics, and educational and training philosophies did not indicate significant correlations with program sustainability.

Partnerships between business and industry and community colleges allow stakeholders to combine expertise in the education and training of students (Gruber, 2000). In the current study over 80% of the respondents' programs had a high degree of partnering with business and industry (See Appendix G, S1). One program participant stated, “Partnership between local industry and the college has been critical to our sustainability. This involves support for both financial needs and student involvement with industry” (Survey Response to Part IV). Another program participant took the level of partnering beyond business and industry stating that an important part of sustainability is “…building program alliance between educators, professionals at companies that hire graduates, leaders in civic, municipal and government agencies, and program graduates” (Survey Response to Part IV). One large program participant, commenting on program sustainability, stated, “[Colleges] need to aggressively increase industry partnerships to not only increase funding but to improve the job pool for program graduates” (Survey Response to Part IV). Additionally, another large program participant commented, “Our Biotechnology program at … is strongly supported by the local industry in terms of curriculum development, equipment donations, scholarships and employment opportunities” (Survey Response to Part IV).

One small program participant suggested partnerships with business and industry could help alleviate certain issues affecting program sustainability stating:

> …these chemical companies still will not invest in the colleges and students. They assume as in the old days, that it’s someone else’s job to supply the new technicians. With the increase in tuition and living expenses, many individuals are priced out of the college market. Simple things like college scholarships and sending prospective employees to the chemical programs would help. (Survey Response to Part IV)

Supporting this comment, another small program participant said “By far the interaction and ‘buy-in’ of local industry is the most important factor with regard to sustainability” (Survey Response to Part IV). Business and industry should look to their local colleges to provide them with well qualified students and develop partnerships to enhance the training required for employment.

Partnerships can provide an avenue for employers to offer expertise in assisting in curriculum development. One characterization of a successful partnership between business and industry and the college is having collaboration in the design and delivery of the training required (York, 1995). Eighty-six percent of the participants indicated their program had extensive employer input in the development of CBTT curricula (See Appendix G, S9). One participant, from a highly sustainable program, stated:

> We have incorporated industry needs and suggestions in curriculum development from the beginning of the program in 1991. Industry laid out the needs and our faculty developed the curriculum.... We have adapted and expanded degree options over the years to meet continuing needs of industry. (Survey Response to Part IV)

Partnerships that utilize experiential learning opportunities can provide an avenue for students to make the college to employment transition easier. The majority of the program participants (76%) thought their students had considerable access to experiential learning opportunities in the form of internships or multi-venue training (See Appendix G, S8). One respondent stated:

> We offer the student the opportunity to work with industry for one semester, usually in the summer. The local companies have placed our students in a job situation where they could gain hands-on experiences with chemical plant operation, and paid them a reasonable wage in addition to providing the experience. (Survey Response to Part IV)

Another participant commented:

> …in a community college it is difficult, but not impossible, to create internship opportunities for students both from an academic standpoint

> (e.g., giving students credit for the experience) and from an availability standpoint (e.g., industry being willing to provide an internship). (Survey Response to Part IV)

Further support for establishing experiential learning opportunities came from another program participant who said, "[Program sustainability needs] increased availability of internships within local industries" (Survey Response to Part IV).

Partnering with business and industry is often an outcome of a college's responsiveness to the needs of its community. In the current study, the overwhelming majority of respondents (90%) felt that their college was highly responsive to their local training employer needs (See Appendix G, S2). Only 3% of the respondents felt their college was not highly responsive to the needs of their local business and industry.

Leadership that is committed to a mission that is market-responsive is important in identifying the needs of business and industry and contributing to the promotion of partnerships (Zmetana, n.d.). Of the 95 survey participants, 73% felt that their college administration had been active in promoting partnerships with business and industry for their CBTT programs (See Appendix G, S3).

Administration's support for CBTT program partnerships oftentimes involves the college president. Overall, 64% of the respondents felt their college president was very involved with the strengthening of the effectiveness of their CBTT program partnership with business and industry (See Appendix G, S4). However, a sizeable percentage (28%) could not agree or disagree with regard to the involvement of their president with partnerships. These responses may be due to the participant's lack of knowledge of the president's involvement in partnering or there is a communication gap among program participants. Although college presidents may be involved with partnerships, Brand (1997) pointed out that they may be far removed from the day to day operations of the college and those involved in those operations.

In summary, statistical analysis of the survey data revealed strong associations between six of the sub-factors within the clustered category of Partnerships. These relationships suggest that program sustainability is related to a high degree of partnerships with business and industry, employer participation in the development of curriculum, and experiential learning opportunities for students. The associations further indicate sustainable programs exist at colleges that are highly responsive to the training needs of business and industry, have administrators that are actively promoting partnerships, and have an involved college president.

Employer and student educational goals. The relationships between each of the sub-factors in the clustered category of Employer and Student Goals and a program's sustainability were analyzed through correlational statistics. A summary of these results is presented in Table 31.

Table 31: *Rating Correlations of Employer and Student Educational Goals with Program Sustainability*

Independent Variable	Pearson Correlation	Significance
Job Skill Standards	0.46	0.00 **
Degree of Student Job Placement	0.38	0.00 **
Number of Program Graduates	0.33	0.00 **
Employability Skills	0.15	0.16
Industry's Hiring of Non-Graduates	0.11	0.31
ACS Skill Standards	0.05	0.66
Transferability of Program Credits	0.02	0.83

N = 95

** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

The results indicate strong relationships between CBTT program sustainability and the use of job skill standards developed by local industry, state labor boards, or professional organizations. There were also significant correlations between sustainability and the degree of student job placement, as well as the number of program graduates through a degree or certification.

Regional job skill standards are frequently used in professional technical training for educators to aid students in meeting employer goals. A majority of program participants (78%) felt that job skill standards developed by regional industries, state labor boards, or professional organizations had been an essential component of their CBTT program (see Appendix G, S10). One of the program participants stated:

> With respect to skills standards we do not have a local laundry list of skill standards – what we teach is developed through interaction with the

> local biotech community including mid level management, lab managers, and former students who are now employed in the industry. (Survey Response to Part IV)

Another program participant stated the need for:

> Continued input from industry on the needs and attention to the skill gaps perceived in new hires. Industry needs to expect that we can render these gaps away if they will share what these are. (Survey Response to Part IV)

Not only are employer skill standards important to sustainability, but student job placement is also significant. In the current study, only 8% of the participants indicated that their CBTT program students did not have a high degree of job placement in industry (See Appendix G, S15). The majority of participants agreed that their students were able to obtain employment relative to their training. One program participant indicated, “The high demand for graduates is fueling a major rise in enrollment, both for Chem Lab and Process Technology” (Survey Response to Part IV).

The current study had only one participant from an inactive program and that person noted:

> The most important factor which would have contributed to the sustain-ability of our program would have been the hiring of our graduates. The program was terminated because, at that time, representatives of the local chemical industry told us that they could hire folks with a Bachelor degree for about the same money as folks with an Associate degree, so they were not hiring our graduates. (Survey Response to Part IV)

In addition to student job placement, the current study found that the number of graduates influenced program sustainability. The current study showed a majority of the participants (80%) believed that the number of students graduates strongly influenced the sustainability of their programs (See Appendix G, S13). One program participant stated:

> …we are in need of students who seek this educational avenue as their first choice. We have employers constantly looking for trained students, but we have very few students who complete the program annually. The jobs are there and the pay is excellent, however the students are not. (Survey Response to Part IV)

In summary, in the clustered category of Employer and Student Educational Goals, three significant correlations with sustainability were detected: use of job skill standards, the degree of student job placement, and the number of program graduates. About 80% of the respondents felt that the use of job skill standards were integral to their program's sustainability. Over 90% of the programs surveyed indicated a high degree of job placement for their program graduates. Finally, approximately 80% of the participants believed that the number of program graduates influenced sustainability. These relationships suggest that sustainable programs utilize job skill standards and have high degrees of job placement and program graduates.

Faculty and their resources. The relationships between program sustainability and each sub-factor in the clustered category of Faculty and Their Resources were analyzed through correlational statistics. A summary of these results is presented in Table 32.

Table 32: *Rating Correlations of Faculty and Their Resources with Program Sustainability*

Independent Variable	Pearson Correlation	Significance
Funding from Outside Sources	0.52	0.00 **
Presence of a Champion	0.31	0.00 **
Administration Emotional Support	0.28	0.01 **
Flexible Scheduling of Classes	0.24	0.02 *
Faculty Professional Development Opportunities	0.22	0.03 *
Obtaining and Retaining Faculty	-0.17	0.10
Quality of Instruction and Use of Part-time Faculty	-0.15	0.15
Excessive Faculty Workloads	0.05	0.66
Classroom and Laboratory Funding	0.04	0.69
Equipment and Instrumentation Funding	0.03	0.81
Faculty Position Funding	0.00	0.96

N = 95

** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

Several of the sub-factors in the clustered category Faculty and Their Resources were strongly correlated to sustainability: continued support from outside funding, the presence of a champion, administrative emotional support, flexible scheduling, and faculty professional development opportunities.

Oftentimes funding comes from sources outside the college to support CBTT programs. In the current study, most program participants (74%) suggested that funding and other resources outside the college provided continued support to their programs (See Appendix G, S23). Very few participants (8%) felt their program was not being provided with continued support from outside resources. One large program participant said, “Grant funding (U.S. Dept. of Labor) has been essential to purchase updated biotechnology laboratory equipment for the program" (Survey Response to Part IV). Another large program participant said:

> We have been working closely with industry (and getting support in the way of donations of money, equipment, and technical help) for many years. We are handling a lot of the training for our local plants—and this helps assure the program will continue. (Survey Response to Part IV)

Further commentary came from another large program participant who stated, "Leveraged resources from employer partners and other grants are the primary factor in program development and sustainability" (Survey Response to Part IV). Another comment from a large program participant regarding factors associated with program sustainability pointed out, "[Program sustainability is dependent upon] primary sources of funding and the percent of funding from the principal sources. Primary sources of funding [include] NSF grants, DOL grants, industry funding, [and] State funding" (Survey Response to Part IV).

In lending support for faculty and their resources, the presence of a "champion" plays an important role. A champion is a leader who effectively advocates for the support of the program and its partnerships. Many of the participants (76%) believed that a champion was present at their college who had contributed to the leadership and support of their CBTT program (See Appendix G, S26). Only a small percentage of the participants (8%) disagreed. One survey participant felt that having a champion present "…is the single most important…" factor to program sustainability. In addition, this individual felt that there needed to be a champion present from both industry and the college. Further support of the importance of a champion's presence came from a program participant saying, "The effectiveness of the program manager in being innovative, developing partnerships, developing the program based on state, national and industry guidelines has resulted in an effective program with sustainability potential" (Survey Response to Part IV).

Support for CBTT programs does not only involve monetary resources. According to Brewer and McMahan-Landers (2003) college administrators should direct their attention toward supervisory policies that improve morale. The current study indicated that 45% of the participants thought their college administrators supported their program instructors through encouragement in morale building and job satisfaction (See Appendix G, S25), but 21% of the participants indicated college administrators did not provide such support.

Another faculty resource that a college may provide is the ability to offer flexible scheduling. Flexible scheduling may result in greater interest in the program from business and industry, as well as from students; thereby increasing enrollments as well as retention. There are several resources that are required to schedule courses at alternative times or venues, including: sufficient numbers of faculty, classrooms, equipment, and laboratories. In the current study, 58% of the participants agreed that flexible scheduling by their college had resulted in improved educational opportunities for students (see Appendix G, S27). One program participant pointed to the need for "adequate space and lab facilities" as an important factor regarding a program's sustainability (Survey Response to Part IV). Another program participant stated:

> We have very active programs that are customized to match industry needs-- both with regularly scheduled semester long classes and with custom ones. This year we have provided around 3500 "physical hours of instruction" to industry classes (not regularly scheduled classes even

> though most of the hours went toward courses that are in the catalog) and expect to provide about 1800 more before the year ends. This has been quite a load on the faculty because it is added to our normal teaching load in most cases. (Survey Response to Part IV)

Professional development for faculty provides the knowledge and skills necessary to sustain professional technical programs (Lawrenz & Keiser, 2001). In the current study, 45% of the participants felt their college provided plenty of opportunities for CBTT program faculty, with 27% in disagreement (See Appendix G, S19). Supporting the need for professional development opportunities, one program participant stressed "interaction with the ACS and faculty at other institutions" as an important factor associated with program sustainability (Survey Response to Part IV). In addition, individuals from academia, government, industry, and professional organizations should be vigilant of the need for professional development for faculty in science-related areas, such as technological advancements. Business and industry tend to be interested in students that have current and advanced training to meet the future needs of society.

In summary, the results showed there was evidence of strong relationships existing between sustainability and continued support from outside resources, the presence of a champion, administration emotional support, flexible scheduling, and professional development opportunities. These relationships suggest that a sustainable CBTT program is one that has continued support from outside sources, the college has a champion advocating effectively, an administration that provides emotional support in the form of morale building and job satisfaction, flexibility in scheduling, and substantial professional development opportunities.

Community perceptions and marketing strategies. The relationships between program sustainability and each of the sub-factors in the clustered category of Community Perceptions and Marketing Strategies were analyzed through correlational statistics. A summary of these results is presented in Table 33.

Table 33: *Rating Correlations of Community Perceptions and Marketing Strategies with Program Sustainability*

Independent Variable	Pearson Correlation	Significance
Community Visibility of Program	0.36	0.00 **
Positive Perception of the Profession	0.31	0.00 **
College Marketing Plan	0.30	0.01 **
Program Promotion to Secondary Students	0.26	0.01 **

N = 95

** Correlation is significant at the 0.01 level (2-tailed)
 * Correlation is significant at the 0.05 level (2-tailed)

The results showed there was evidence of strong relationships existing between all of the sub-factors and program sustainability within the clustered category of Community Perceptions and Marketing Strategies. Having a program with high visibility and a good reputation for securing employment is important to the continuance of a program. One program participant suggested that to sustain a program we need to promote a, "Better awareness of the job opportunities for these students" (Survey Response to Part IV). In addition, another participant stated, "Essentially everyone tells me that they cannot get nearly enough students in the door to meet industry demand. There appears to be a lack of information about the quality and quantity of available jobs in the oil/petrochemical industry" (Survey Response to

Part IV). Of all of the participants, only 39% of the participants felt their program was highly visible to prospective students.

Engelman (2005) asserted that although the chemistry-based profession had improved over the years, it has suffered a negative public view. The current study found that only about 43% of the participants felt their community's perception of the chemistry-based technician profession was positive (See Appendix G, S29). One respondent suggested that there needs to be a "…better image for CBTT programs." Another participant stated:

> …there are two communities to consider – biotech community/industry perception is extremely positive – we generally place 10-20 students per semester at full time jobs. The general public's perception is just the opposite, for the most part the "average citizen" has a negative perception of the Biotech program, this includes the public school system…. (Survey Response to Part IV)

The local communities' perception of CBTT programs is important in the recruitment and retention of students. Local government, business and industry, and the college may consider advertising which can present a positive light on the chemistry-based technician's profession to assist in promoting the program.

Making a program visible and improving the community's perception may be assisted through a college's marketing strategies. Promoting a professional technical program requires the identification of the college's community, setting goals, and implementing a mix of marketing strategies (Shubird, 1990). In the current study, many of the participants (46%) felt their college did not have a marketing plan that positively contributed to the enrollments of students (See Appendix G, S30).

Several program participants were concerned about attracting well qualified students, and one participant remarked, “We need to find students who are skilled and motivated to learn the difficult concepts of chemistry, but who want to complete a two-year degree as opposed to a four-year degree” (Survey Response to Part IV). One program participant suggested, “The college must expend funds in advertising campaigns to let the public know that the program exists” (Survey Response to Part IV). Another program participant stated:

> Most students interested in chemistry often attend four-year universities instead of two-year community and technical colleges. Universities tend to focus on science majors interested in advanced degrees in numerous fields-- everything from doctor to chemist to engineer. I do not think that students know that they could obtain a chemistry job after only two years of education. We have now incorporated our chemistry technology program into our science department hoping to attract students taking science courses. (Survey Response to Part IV)

Further comment on this subject came from a small program participant saying:

> Even though 25% of all the industrial chemistry personnel is retiring in the next decade, and the job market is wide open, students opt to major in areas where there is [*sic*] less opportunities. We currently have 100% placement within days of graduation and the chemical companies are in need of technicians. (Survey Response to Part IV)

Another small program participant remarked:

> This program was essentially dead for 2 years because the previous instructor did not promote the program. The college itself does nothing by way of advertising to promote the program. This is left solely to the one instructor for the program …. (Survey Response to Part IV)

Another participant commented:

> Those of us close to the program have been unsuccessful at moving the College toward improved promotion of our CBTT programs. Other work force areas such as nursing and trade related programs receive more attention. I believe we would have more students and graduates if our

> College made more direct investments in the CBTT programs, including actively marketing and promoting our programs. (Survey Response to Part IV)

In contrast, one participant stated that although the college had begun an "aggressive marketing/outreach campaign for biotechnology," they had not yet seen any noticeable improvements in the program enrollments. The improvement of community perceptions, in combination with a strong marketing strategy, may be a focal point of interest for CBTT program administrators and faculty.

Marketing to a college's local community includes reaching out to secondary school students. The current study investigated college promotion and marketing of CBTT programs to secondary school students. Although several participants (39%) indicated that their college actively promoted their programs to secondary students, slightly more participants (41%) did not agree (See Appendix G, S31). One participant stated that "The program needs to be presented to the high schools in a way that overcomes the idea that if the program doesn't lead to a four-year degree, then it is suited for the less talented student" (Survey Response to Part IV). Another respondent said "…the high school faculty, councilors [*sic*] and administrators discourage their students from applying to a two-year college because those enrollments reflect poorly on them" (Survey Response to Part IV). Another participant expressed a concern in promoting their program to secondary schools citing "[The] quality of students exiting secondary education. Many have limited math skills, let alone chemistry and physics exposure" (Survey Response to Part IV). In addition, a participant said that they had "…completed three or four presentations at various High Schools with little to no interest. We are trying to work with HS teachers to help promote our program. We just need to persevere!" (Survey Response to Part IV). Another participant suggested, "High schools need to promote these programs through their guidance office" (Survey Response to Part IV). Additional commentary came from another participant stating:

> Students in middle school and high school are not aware of career opportunities provided by a chemistry-based technician training program. Hence there is little motivation to prepare oneself for such a career, especially in the areas of mathematics and science courses. Parents and teachers are also not aware of these career opportunities and thus students are not encouraged to pursue such a program. These factors contribute to low enrollment in classes and to lower retention rates. (Survey Response to Part IV)

Finally, one participant suggested, "There needs to be a stronger marketing initiative with secondary students in middle and high school regarding the career opportunities…" (Survey Response to Part IV).

The results of the correlational analysis showed there was evidence of strong relationships existing between all of the clustered category sub-factors with Community Perceptions and Marketing Strategies and program sustainability. These relationships suggest that a sustainable program is highly visible to its local community, has a positive community perception of the CBTT profession, and the college has a strong marketing plan that includes promoting the program to local secondary students.

Summary. Pearson coefficients and their associated levels of significance revealed that there were strong relationships between CBTT program sustainability and 18 of the 31 sub-factors. The significantly correlated sub-factors shown below are ordered by decreasing strength of their association with program sustainability:

- Partnerships with business and industry
- Funding and other resources from sources outside the college
- The use of job skill standards
- Employer input in curriculum development
- High degree of job placement for students
- High visibility of the program in the community
- Having experiential learning opportunities for students
- Number of program graduates
- The presence of a champion
- Positive perceptions of the chemistry-based profession
- A college marketing plan
- Emotional support from administrators
- A college responsiveness to the training needs of local business and industry
- Administration that is active in promoting programs
- Marketing the program to secondary students
- A president that is involved with strengthening partnerships
- Flexible scheduling
- Professional development opportunities

In order to explore correlations between the sub-factors and program sustainability in more detail, statistical analyses were performed on the ratings by small and large program participants. The analysis is provided in Appendix H.

To address the question of the existence or extent of interrelationships among the various sub-factors associated with CBTT program sustainability, and to determine the comparative importance of different variables, multiple regression analysis was applied to the survey response data. The results of this analysis are presented in the next section.

Multiple Regression Analysis

In attempting to determine the relationship of the combined factors associated with CBTT program sustainability, this researcher performed multiple regression analysis on the survey ratings. The model provided by the multiple regression analysis offered additional information with regard to an explanation of program sustainability. Multiple regression is a statistical technique that allowed this researcher to determine which sub-factors were contributing more or less to the dependent variable. Aspects of CBTT programs are naturally diverse and therefore it is not possible to produce a totally accurate predictive model for sustainability. Notwithstanding, through multiple regression analysis, this researcher was able to develop a model that included variables that were mutually related to CBTT program sustainability. The Statistical Packages for the Social Sciences (SPSS) software was used in a stepwise progression which allowed the program to calculate the unique contributions of the sub-factors to the dependent variable (program sustainability). Multiple regression analysis formulated the contributions of independent variables into a model that revealed four factors that were strongly related to the dependent variable (sustainability). A summary of the results of the stepwise multiple regression analysis is provided in Table 34.

Table 34: *Summary of Multiple Regression Analysis of the Sub-Factors Associated with Program Sustainability*

Independent Variable	R	R^2	B	Significance
(Constant)			1.383	0.006
Degree of Partnering	0.574	0.330	0.381	0.000**
Funding from Outside Sources	0.640	0.410	0.286	0.002**
Community Visibility of Program	0.668	0.446	0.172	0.015*
Administrative Style Differences	-0.166	0.470	-0.210	0.000*

Dependent Variable: Sustainability

** Significant at the 0.01 level
 * Significant at the 0.05 level

N 95

The R^2 value for the model presented was determined to be 0.470 with an overall p-value of 0.000. According to the model, about 47% of the variation in a CBTT program sustainability rating can be explained by knowing the degree of partnering, level of support and funding from outside sources, visibility of the program to the local community, and the extent of differences in the administrative styles between the college and business and industry. Each of the sub-factors does not equally explain program sustainability. The amount of increase in R^2 when each of the sub-factors was added in the stepwise progression suggested that much of the relationship is due to the degree of partnering. However, the other sub-factors still contributed to the correlation to program sustainability, but carried less weight. In addition, as with other correlation coefficients, the negative beta weight for differences in administrative styles indicated an inverse relationship with program sustainability.

In other words, programs without differences in administrative styles tend to have a greater potential for a higher sustainability rating.

Another statistical method used to reduce the number of explanatory variables related to sustainability ratings is factor analysis. Individuals involved or interested in CBTT programs may find the statistical procedure worth further investigation. For those interested, other multiple regressions and a factor analysis of the data appears in Appendices I, J, and K.

Summary

Of the participants, 76% indicated their program was sustainable. The data from small program participants indicated 58% had some degree of sustainability as compared with 86% of large program participants. The correlation coefficients relating the 31 sub-factors with program sustainability suggested that a sustainable program tends to have partnerships with business and industry, has continued resources from outside the college, and uses job skill standards and employer input in curriculum development. Sustainable programs also have a high degree of job placement for students, high visibility of the program in the community, and experiential learning opportunities for students. In addition, the number of program graduates influences program sustainability as well as having a champion present. Other factors that influence program sustainability are positive perceptions of the chemistry-based profession, a college marketing plan, emotional support from administrators, and being responsive to the training needs of local business and industry. Administrators who are active in promoting programs, marketing the program to secondary students, a president that is involved with strengthening partnerships, flexible scheduling of the program, and professional development opportunities are also strongly associated with program sustainability.

Multiple regression analysis of the ratings of the sub-factors provided a model that took into consideration the contributions of the independent variables to sustainability. The SPSS interpretation resulted in the selection of four factors that had a cumulative R^2 value of 0.47, indicating that 47% of a program's sustainability rating could be explained by the degree of partnering, continued funding and other resources from outside sources, community visibility of the CBTT program, and the absence of administrative style differences. The next chapter begins with a summary of all of the analyses from the collected data.

CHAPTER 5

Discussion, Conclusions, and Recommendations

This study was designed to identify, examine, and analyze the most significant factors associated with economic sustainability of two-year chemistry-based technology training programs. Three research questions were investigated to determine: (a) the relative importance of four clustered categories of identified sub-factors, (b) potential differences in opinions of administrators and faculty in large and small programs, and (c) interrelationships among the factors. This researcher developed an opinion-based survey and measured administrator and faculty perceptions of factors related to CBTT program sustainability. This chapter provides a synopsis of the research findings, their relationship to applicable topics in the review of literature, and a summary of the research results. The chapter also provides recommendations for individuals in education, business and industry, professional organizations, and legislators who are interested in two-year CBTT programs. Finally, a discussion of the study's limitations and potential topics for further research are presented.

The research was conducted by surveying CBTT programs throughout the United States. The population consisted of programs listed in the American Chemical Society's Directory of Chemistry-Based Technology Programs. Quantitative and qualitative data were collected from faculty and administrators of 63 programs in 29 different states. Based on the use of 134 programs contacted, the program response rate was 47%, and a non-response follow-up survey was not conducted. However, of the 134 programs initially contacted, 22 of the programs are no longer inexistence.

The quantitative data were obtained from participant rankings and ratings, while the qualitative data was gathered by including one open-ended question in the survey. Results from the demographic portion of the survey indicated that the respondents were reasonably representative of participants from all U.S. CBTT programs, see Appendix D.

Discussion and Interpretation of the Findings

This discussion will be organized by the three research questions. Research question one was answered from the mean rankings of the responses of survey participants that determined the order of importance of each of the four clustered categories of sub-factors related to CBTT program sustainability. The order of ranking by all program participants, from highest to lowest was: (1) Partnerships, (2) Employer and Student Educational Goals, (3) Faculty and Their Resources, and (4) Community Perceptions and Marketing Strategy.

The rankings were further statistically analyzed according to program size. The Mann-Whitney test of significance revealed significant differences ($p < 0.05$) between small and large program participants in their rankings of Community Perceptions and Marketing Strategies and Employer and Student Educational Goals. Additionally, in contrast to large programs, small program participants ranked Faculty and Their Resources higher in importance to sustainability than Employer and Student Educational Goals. Small programs may feel it necessary to give more attention to faculty and their resources to support program sustainability than larger programs. These differences in opinions regarding the ranked orders of importance of the clustered categories suggested that small and large programs should be considered independently when assessing the identified sub-factors that are most strongly related to sustainability.

Research question two was answered from the mean rankings of the responses of faculty and administrators. Unlike comparisons of large and small program participants, analysis of the data of the four clustered categories by faculty and administrators indicated no significant differences in rankings.

Research question two was also answered by utilizing the Mann-Whitney test of significance to determine if there were significant differences in the opinions of faculty and administrators with respect to the ratings of program sustainability and the related sub-factors by the participants. No significant differences were determined in their program sustainability ratings and only two of the sub-factors had significant differences of opinions: the extent of employer input in curriculum development and the effect of excessive faculty workloads as they relate to program sustainability.

The Mann-Whitney test was also used to determine if there were significant differences between large and small program participants in their ratings of program sustainability and the related sub-factors. Significant differences were found between groups in ratings of their program sustainability and the following sub-factors: (a) degree of partnering, (b) administration's promotion of partnerships, (c) number of program student completions, (d) funding and other resources from outside sources, (e) administration emotional support, (f) presence of a champion, (g) flexible scheduling of classes, (h) community visibility of the CBTT program, (i) positive perception of the chemistry-based profession, (j) college marketing plan, and (k) promotion of the program to secondary students.

Further analysis of the differences of opinions of the participants was explored through MANOVA by testing interrelationships involving four groups: (a) small program faculty, (b) large program faculty, (c) small program administrators, and (d) large program administrators. The analysis revealed significant differences among the ratings of the sub-factors contained in three of the four clustered categories: (a) Employer and Student Educational Goals, (b) Faculty and Their Resources, and (c) Community Perceptions and Marketing Strategies. The ratings of the sub-factors within the clustered category of Partnerships showed no significant differences among the four groups of survey participants.

Post hoc tests indicated disagreements in the perspectives of large program administrators and small program faculty for the following sub-factors associated with their program's sustainability: (a) number of program graduates, (b) excessive faculty workloads, (c) funding and other resources from outside the college, (d) administration's emotional support, (e) flexible scheduling of classes, (f) community visibility of the program, (g) community perception of the chemistry-based profession, and (h) college marketing plan, see Figure 14. Disagreements of perspectives do not reflect degrees of importance of the sub-factors, but rather that differences exist based upon a participants' position and program size. These disagreements suggested that as programs change in size attention should be given to changes in strategies, collaboration, and commitment toward maintaining sustainable programs.

X - Indicates a significant difference in ratings

	Number of Program Graduates	Excessive Faculty Workloads	Funding From Outside Sources	Administration Emotional Support	Flexible Scheduling of Classes	Community Visibility of the Program	Positive Perception of the Profession	College Marketing Plan	Program Promotion to Secondary Students
Large Program Administrators and Small Program Administrators					X	X			
Large Program Administrators and Large Program Faculty									
Large Program Administrators and Small Program Faculty	X	X	X	X	X	X	X	X	
Small Program Administrators and Large Program Faculty						X			
Small Program Administrators and Small Program Faculty		X							
Small Program Faculty and Large Program Faculty							X		X

Figure 14: Summary of significant differences in the ratings of the sub-factors by the four groups of participants.

Large and small program administrators significantly disagreed on their ratings of the following sub-factors: (a) flexible scheduling, and (b) community visibility of the program of the chemistry-based profession, see Figure 14. Large program faculty and small program administrators also disagreed on the sub-factor community visibility of the program. These differences in opinions between small and large program participants further substantiate variations in the characteristics and possible needs of different-sized programs.

There were significant differences in the opinions of large and small program faculty with respect to two of the sub-factors: (a) community perception of the CBTT profession, and (b) the promotion of CBTT programs to secondary students, see Figure 14. Again, this difference in opinions emphasized the importance of program size on the factors related to sustainability.

Small program faculty and small program administrators significantly disagreed on only one of the sub-factors, excessive faculty workloads, see Figure 14. The difference of opinion regarding faculty workloads is not solely program size dependent, but also reflects disparity in the perspectives of small program administrators and faculty. The fact that large program faculty and administrators did not disagree on this issue suggested that the difference in opinions between small program faculty and administrators regarding faculty workloads deserves attention.

Finally, there were no significant differences in the ratings of the sub-factors that relate to program sustainability between large program faculty and administrators. This agreement of perspectives suggests that large programs may have more effective faculty-administrator communication, collaboration, and joint agreement on the issues or sub-factors regarding sustainability. Although the issues facing small program participants may be very different from those of large programs, CBTT participants may be able to learn from some of the best-practices of large program facilitation.

Research question three was answered through the ratings by the participants of the 31 sub-factors' relationships to their program's sustainability rating. Pearson correlation coefficients and their associated significance levels showed there were strong relationships between CBTT program sustainability and the following sub-factors: (a) degree of partnering, (b) responsive college, (c) involvement of administration (including the president) in partnerships, (d) experiential learning opportunities, (e) employer input in curriculum development, (f) use of job skill standards, (g) the number of program graduates, (h) student job placement, (i) funding and other resources from outside the college, (j) professional development opportunities, (k) emotional support from administrators, (l) presence of a champion, (m) flexible scheduling, and (n) visibility of the program, (o) positive perception of the chemistry-based profession, (p) a college marketing plan, and (q) promoting the program to secondary students, see Figure 15. It should be pointed out that not only are significant associations between program sustainability and the factors important, but absences of relationships are also worthy of consideration.

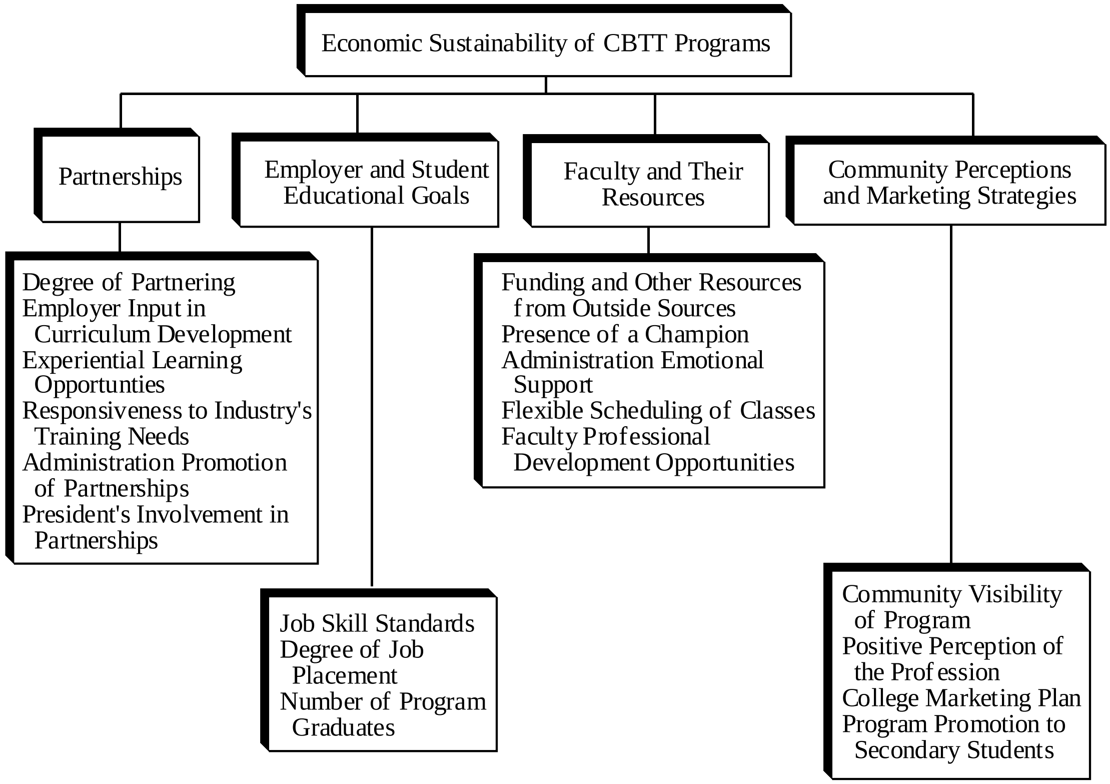

Figure 15: Clustered categories and the significant factors associated with CBTT program sustainability.

In the clustered category of partnerships, the current study found strong correlations between program sustainability and the sub-factors: (a) degree of partnering, (b) employer input in curriculum development, (c) experiential learning opportunities, (d) responsiveness of industry’s training needs, (e) administration’s promotion of partnerships, and (f) the college president’s involvement in partnerships. Several authors, including Spangler (2002), Gruber (2000), Sundberg (2002), and Gibbs (2005) asserted that partnerships were essential components of successful professional technical training programs. Gruber (2000) and Zinser (2003) pointed out that employer input in curriculum design is an important component of technical training, but that many programs are lacking this input. The current study’s survey indicated a strong association between employer input in curriculum development and sustainability among the participants, but no significant differences detected among the large and small program faculty and administrators. The importance of experiential learning opportunities was emphasized by ChemTechLinks (ACS 2006b), the PACT survey (2000), and Schmidt (1998). Programs with experiential learning opportunities were found to be strongly associated with sustainability ratings in the current study. In addition, the sub-factor, experiential learning opportunities, which included internships, was one of the four sub-factors identified in a model derived from multiple regression analysis. This model may be used to assist in explaining the sustainability ratings of CBTT programs. Harmon and MacAllum (2003), studied several publications regarding the responsiveness to business and industry's training needs as an important goal for community colleges. The current study found strong associations between CBTT program sustainability and how responsive the college was in meeting the needs of employers. The involvement of the college administration in partnership building was presented by Good, Killian, Marine, Neils and Singer (2006). Furthermore, Brand (1997) suggested the importance of having a college president involved in these partnerships. Survey participant data indicated strong correlations between program sustainability ratings and administration's involvement in promoting partnerships. In addition, the college president's involvement in strengthening partnerships was also strongly correlated with program sustainability.

There were three sub-factors in the clustered category of Employer and Student Educational Goals with strong correlations to sustainability: (a) job skill standards, (b) degree of student job placement, and (c) number of program graduates.

The use of job skill standards was one of the critical issues identified in the ChemTechLinks study (ACS 2006b). The use of job skill standards developed by regional industry, state labor boards, or professional organizations was significantly correlated with CBTT program sustainability ratings. The sub-factor regarding the use of ACS skill standards did not have a significant relationship to sustainability ratings, which may be due to the variety of programs surveyed, such as biotechnology and environmental technology. The ChemTechLinks report (ACS, 2006b) emphasized that students entering training programs want assurances of job placement and the current study showed that the degree of job placement was significantly related to program sustainability ratings. In addition, Lawrenz and Keiser (2001) asserted that the numbers of students completing programs may be related to program sustainability. The current study further substantiated these assertions in that there was a strong association between program sustainability and the number of students completing CBTT programs through a certificate or degree.

The clustered category of Faculty and Their Resources had five sub-factors that were strongly correlated to program sustainability ratings: (a) funding from outside sources, (b) presence of a champion, (c) administration emotional support, (d) flexible scheduling of classes, and (e) professional development opportunities. The importance of continued funding from sources other than the college, such as from grants from government, business, and industry, have been documented by the ACS (2006b), Grubb, et al. (1999), Gruber (2000), and Lawrenz and Keiser (2001). These findings were confirmed by the current study’s data. The sub-factor, funding from outside sources, was also a component of the model identified through multiple regression analysis that may assist in explaining sustainability ratings. The importance of the presence of a champion appeared in several studies reviewed in the literature (ACS 2006b; Scheirer 2005; Youngs, 2007). For this study, a champion was defined as a leader that effectively advocates for support of the program and its partnerships. The survey data provided evidence that sustainability ratings were strongly associated with programs with a champion from the college who contributed to leadership and support. Administration emotional support of faculty in professional technical training programs was addressed by Brewer and McMahan, (2004), Brewer and McManahan-Landers (2003) and Ruhland (2001). They recommended that administrators should be involved in the process of improving morale and instructor retention methods. The current study indicated a strong relationship between CBTT program sustainability and college programs that had administrators who strongly supported instructors through their encouragement toward morale building and job satisfaction. In addition, the importance of professional development opportunities for faculty was discussed by Grubb, et al., (1999), Lawrenz and Keiser (2001), and Mahoney and Barnett (2000). The current study revealed that professional development opportunities for CBTT instructors were strongly associated with sustainability ratings. The importance of flexible scheduling by community colleges was pointed out by Jacobs and Voorhees (2006), Sundberg (2002), and UNESCO (2002). The current study revealed a strong correlation between college programs that provided flexible scheduling and CBTT program sustainability ratings.

The clustered category of Community Perceptions and Marketing Strategies contained four sub-factors that were strongly interconnected as well as strongly associated with CBTT program sustainability ratings. The review of literature (ACS, 2006b; Lawrenz & Keiser 2001; PACT 2000; Zinser & Lawrenz, 2004) disclosed a wide-spread belief that programs that were highly visible and had a positive perception of the profession in the community were more successful. Furthermore, colleges that had strong marketing plans assisted in the success of these programs. The current study indicated that all of these factors were strongly correlated with CBTT program sustainability ratings.

There are three sub-factors that deserve comment, even though they were not significantly correlated with CBTT program sustainability ratings: (a) administrative style differences, (b) transferability of program credits, and (c) the impact of excessive faculty workloads. The review of literature revealed a variety of concerns regarding the interaction between administrators in community colleges and those in business and industry (Bailey, Alfonso, Scott, & Leinbach, 2004; Drumm, et al., 2006; Jacobs, 2001; Zinser & Lorenz, 2004). The relevance of differences in administrative styles came to light in the current study through multiple regression analysis which placed this sub-factor in a model that may assist in the explanation of the program sustainability ratings.

The issue of excessive faculty workloads appeared prominently in the ChemTechLinks (ACS 2006b) report, as well as the PACT study 2000, articles by Grubb, et al., (1999) and Brewer & McMahan (2004). The ACS report stressed that CBTT faculty often have workloads that affect the quality of instruction. Although this sub-factor was not significantly correlated with sustainability ratings, it was one of the most significant differences noted in answering the research question concerned with differences in opinions between faculty and administrators. The differences between faculty and administrators regarding this sub-factor were clearly apparent and deserve consideration in any study of professional technical training programs.

Large program participant data reflected strong relationships between sustainability and the sub-factors: (a) high degree of partnering with business and industry, (b) extensive employer input in CBTT curriculum design, (c) the use of job skill standards, (d) funding and other resources from outside sources, (e) college responsiveness, (f) administration's promotion of partnerships, (g) business and industry's non-hiring practices of students prior to program completion, (h) the degree of student job placement, (i) community visibility of the program, and (j) an effective college marketing plan. See Appendix H for the results of the statistical analyses.

Small program participant data indicated strong associations between sustainability and the sub-factors: (a) high degree of partnering with business and industry, (b) employer input in CBTT curriculum design, (c) the use of job skill standards, (d) funding and other resources from outside sources, (e) experiential learning opportunities, (f) transferability of program credits, (g) instructional quality not affected by the use of part-time instructors, and (h) the presence of a champion, see Appendix H.

Using multiple regression analysis, a model was obtained that revealed that approximately 47% of the variation in a CBTT program sustainability rating could be explained by: (a) the degree of partnering, (b) the presence of funding and other resources from outside sources, (c) visibility of the program to the local community, and (d) the extent of differences in the administrative styles between the college and business and industry.

Recommendations for Individuals Involved with CBTT Programs

The current status of CBTT programs in the United States is cautiously optimistic. While 87% of the participants of the current study indicated a moderate to high demand for trained technicians, 13% felt there was a low or uncertain need in the local job market, suggesting there are some concerns in this area.

Assisting faculty and administrators in the determination of the current and future job market in the local communities is an important aspect of college professional technical training programs. As a first step toward program sustainability, college personnel should have the resources available to them for assessing the employer needs of their community's business and industry. In addition, meeting employer and student goals, including job placement, are important aspects of program sustainability. If students are unable to acquire jobs following the training program, they will be less likely to enroll in CBTT programs.

Partnerships with business and industry are major components of CBTT program sustainability. The survey data showed that programs with partnerships that involve employer input in the development of curriculum, incorporate job skill standards, and offer experiential learning opportunities, tend to have higher sustainability ratings. Along with faculty, administrators should be involved in the promotion of building strong and trusted partnerships with business and industry to ensure program sustainability. Having an actively involved college president in the strengthening of a partnership with business and industry is recommended for sustainable programs. In addition, business and industry should make every effort to collaborate with colleges and to provide experiential learning opportunities for CBTT program students. Although few program participants indicated problems between colleges and business and industry in the areas of education and training philosophies or administrative styles and ethics, difficult situations could arise from a lack of trust, communication, and collaboration. Based on the findings of this study, this researcher recommends that colleges make concerted efforts to work with potential partners to establish strong and trusted relationships that feature mutual input and involvement.

As students move through the education and training provided in the curriculum of CBTT programs, they must consider their own aspirations and goals as well as future employer's needs. Student completions of programs and a high degree of job placement are factors strongly related to the sustainability of CBTT programs. This suggests that employers should refrain from hiring students prior to program completion and work with college personnel to ensure that current and future positions are filled. It is further implied that if business and industry require the program degree or certificate prior to employment of students, program sustainability could be strengthened. Incorporating employability skills into program curricula, such as adaptability, teamwork, problem-solving, and effective communication, are also important aspects of meeting business and industry needs. Program participants should consider the periodic assessment of the effectiveness of incorporating employability skills and whether or not the curriculum is meeting business and industry needs.

The issues that revolve around CBTT programs are many-faceted and require support through various resources. Colleges should be assisted in strengthening their programs by continued support from outside sources in funding and other resources, including equipment and instrumentation. Further assistance in the provision of professional development opportunities for faculty can assist in the development of instruction and curriculum that can meet the needs of business, industry, and students. Program faculty have many responsibilities, such as advising, recruiting, teaching, partnering, developing curriculum, grading, and marketing just to name a few. Administrators should provide support for faculty morale building to alleviate job stress and burnout. Having a champion present that advocates strongly for the needs of the program is particularly important for program sustainability. Resources are not abundant and competition for the few that are available is fierce. Having an effective champion allied with the program provides an avenue for acquiring at least some of the resources available. Although the ability to provide flexible scheduling may be program-size dependent, every effort should be made to meet the demands of students and employers in providing flexibility in how or when classes are offered.

All CBTT programs should be highly visible to the local community. Securing a positive perception of the chemistry-based profession can be made possible through a strong marketing plan for the program. In addition, promotion of CBTT programs and chemistry-based careers to secondary students may create interest and increased enrollments, which will contribute to program sustainability.

The current research suggested that both small and large programs have strong relationships to sustainability in the areas of partnering, employer input in curriculum development, use of job skill standards, and funding and other resources from outside sources. Although there are similarities in the opinions of large and small program participants regarding the factors related to program sustainability, some differences suggest examining programs individually. For example, small programs may want to focus on those factors that they feel strongly relate to sustainability, such as experiential training opportunities, the ability to transfer CBTT program credits, and encourage the presence of a "champion." Likewise, factors that may negatively affect small program sustainability, such as excessive faculty workloads, should be considered. The survey findings suggest that large programs may want to continue directing their attention to such matters as college responsiveness, strong administrative support, high job placement rates for graduates, and program visibility to the community. Furthermore, business and industry should consider the consequences of hiring students prior to completing the CBTT program.

There were significant differences between the opinions of small and large program faculty, as well as between small program faculty and large program administrators, regarding the effect of excessive faculty workloads on sustainability. Because faculty workload issues affect several aspects of CBTT programs, including curriculum development, professional development, and flexible scheduling, this researcher recommends that all participants, regardless of program size, mutually agree on reasonable faculty workloads.

Finally, this researcher suggests CBTT program participants consider alternative strategies to preserve sustainability if the number of students enrolled declines or increases. Small and large programs have different needs and attention to those needs is crucial in maintaining programs. Although large programs are strongly supported by the community, small programs also have an important place in meeting their communities' needs and may require additional outside support from business and industry, professional organizations, and government agencies.

Limitations

There were some limitations associated with the current research study. The work schedules of educators fluctuate during the year, and response rates may have been affected by educators' workloads and summer break. Certain times of the year are much more demanding work-wise than others. The study's request for participation may have come when participants' workloads could not withstand the additional time required. In addition, the study began prior to and during the summer when some participants may have been on academic hiatus. Furthermore, the current study did not determine the degree of non-response bias nor attempt to control for that non-response bias.

There may have been some problems associated with willingness to participate due to a concern about how a program could be portrayed. Although both administrators and faculty were asked to participate in the study, the response rate for faculty was greater than that of administrators. This unequal response may indicate some limitation within the study.

CBTT programs are quite diverse and complex. Although the current study attempted to research a broad range of factors (four clustered categories and 31 Likert scale sub-factors) associated with program sustainability, other unidentified factors may also be significant and worthy of investigation. In addition, the current study used only one rating for the dependent variable, program sustainability, which did not have verification from archived data, such as the number of program graduates, job placements, and longevity of the program.

Individuals associated with the CBTT programs had varying degrees of connectively and knowledge of their programs. This variability of knowledge could have some effect on the individuals' responses to the survey questions. Furthermore, the subjectivity of the rankings and ratings of the participants introduce a bias which may be reflected in the individual's immediate needs as opposed to the actual importance of the sub-factors associated with the survey questions. The current study's cross-sectional survey evaluated CBTT programs at one point in time. It is possible that changes in the issues associated with program sustainability may occur in the future, indicating the need for reassessment of the related topics.

The current study investigated a variety of CBTT programs (biotechnology, chemical laboratory, process technology, pharmaceutical, and environmental). Specific programs, such as biotechnology and process technology, may differ in their organizational structure, goals, and resources from other CBTT programs. In addition, the variety of geographic locations of the CBTT programs may also be a factor that could potentially affect the perspectives of the participants.

The current study did not provide the perspectives of individuals from business and industry, currently enrolled students, or graduated students of CBTT programs. These perspectives could be significant in the development of programs that attempt to meet the needs of all associated stakeholders.

Recommendations for Further Study

Research during other times of the year may provide an alternative perspective from not only the current participants, but also individuals who did not respond to the current study's request. In addition, a study involving the non-participants or controlling for non-response bias may add further information to the research provided by the current study.

Further research involving other stakeholders of CBTT programs, such as students, program graduates, employers, and legislators may provide different perspectives than those of educators. A study of factors affecting these stakeholders would provide an even broader sense of specific needs applicable to program sustainability. The current study investigated employer and student educational goals from the educator's perspective; however students and employers may bring forth alternative and relevant factors that could provide even further insight into program sustainability.

Research specifically addressing each of the different CBTT program types, such as process technology (including size differences) and various geographic locations may provide further insight into program sustainability. Development of a survey specifically addressing the needs of a particular CBTT program type could more clearly delineate the sub-factors for investigation and determine results exclusively for those programs.

This study used the participant's perspective of their program's current sustainability rating. Additional research may be performed using other criteria for program sustainability, such as longevity, number of student's enrolled, number of graduates, number of students employed in CBTT jobs, or the number of partnerships associated with the program. Furthermore, a future investigation of the issues related to program sustainability may provide information as to whether or not these issues have remained constant over time.

The open ended question in the survey asked participants to indicate other factors associated with program sustainability (Survey Response to Part IV). Most of the participants reflected upon those factors contained in the current study. However, some participants pointed out additional factors, some of which are closely related to those contained in the current study. The following factors pointed out by the respondents deserve further consideration for future studies:

- Workforce competencies for graduates
- Industry demand for graduates
- Health of the chemical industry in the U.S.
- Professional advancement opportunities for graduates
- Running small class sizes
- Specific certification and program requirements
- Acceptance of faculty credentialing at a lower level than the “designed for transfer”
- Assigning part of a faculty member’s workload to be marketing agent for the community
- The attraction of well qualified students
- Quality of students exiting secondary education

- Federal funding
- Government regulation and oversight of operator training and qualifications
- Connections to professional organizations beyond skill standards
- Connection with local and regional CBTT programs
- Employment opportunities outside the area
- Funding formula reflection of the cost to train a CBTT student relative to other academic programs
- Continuous quality improvement

Conclusions

Investigating the factors associated with chemistry-based technology training program sustainability was a challenging, enlightening, and productive experience. The survey instrument successfully provided the perspectives of individuals directly participating in CBTT programs. The rankings of the importance of clustered categories and ratings of their sub-factors afforded this researcher vast opportunities for quantitative analyses of the data. An open-ended question in the survey supplied important personal comments from participants regarding program sustainability.

The three research questions were answered using statistical data and postpositivistic interpretations. Rankings of the four clustered categories indicated that Partnerships were regarded as the most important to CBTT program sustainability. There were no significant differences in the rankings of faculty and administrators. However, an investigation of differences in the rankings by participants of large and small programs provided this researcher incentive to further investigate their differences of opinions.

The Mann-Whitney test of significance pointed to significant differences in the opinions of faculty and administration in two of the sub-factors: employer input in curriculum development and the impact of excessive faculty workloads. Multiple analysis of variance disclosed interrelationships among faculty and administrators from different sized programs. A noteworthy finding of MANOVA was that the majority of significant differences among the opinions of the four groups of program participants were between small program faculty and large program administrators. Large program faculty and administrators did not differ significantly in their opinions, indicating that significant differences of opinions are related more to program size than academic position. The one important difference of opinion was evident between small program faculty and administrators was related to excessive faculty workloads.

In order to determine interrelationships among the factors related to sustainability, ratings of the 31 sub-factors contained in the clustered categories were evaluated using descriptive, associational, and inferential statistics. Strong relationships between several sub-factors and sustainability were identified. A multiple regression analysis established a model that included strongly related factors.

In the current study, quantitative analysis was a valuable tool in finding relationships and differences regarding the most significant factors affecting chemistry-based technology training programs. The data were complemented by information from the open-ended survey question. It is hoped that the evaluation and interpretation of the findings of this study further defines and confirms the relationships of the identified factors associated with CBTT program sustainability. Although the findings of this study may be of particular interest to chemistry-based technology educators, this research is also expected to benefit those involved with professional technical training in general. In the future, this researcher intends to use the expertise and knowledge gained from this research experience to assist and support CBTT programs throughout the country.

References

Akerlund, K. M. (2000). Prevention program sustainability: The state's perspective. *Journal of Community Psychology, 28*(3), 353-362.

Altman, D., Endres, J., Linzer, J., Lorig, K., Howard-Pitney, B., & Rogers, T. (1991). Obstacles to and future goals of ten comprehensive community health promotion projects. *Journal of Community Health, 16*, 299-314.

American Chemical Society (ACS). (2004). Science education policies for sustainable reform. *Legislative and Government Affairs.* Retrieved October 24, 2007, from http://www.chemistry.org/portal/resources/ACS/ACSContent/government/statements/2004_10_sci_ed_policy_sus_rfrm_edu.pdf

American Chemical Society (ACS). (2005, April). Enterprise 2015: Preparing for careers in chemical technology. *Executive summary of the national meeting of the American Chemical Society, San Diego, CA*. Retrieved October 12, 2007, from http://www.chemistry.org/portal/resources/ACS/ACSContent/committees/cta/presidential_event_summary_spring2005.pdf

American Chemical Society (ACS). (2006a, January). *Directory of chemistry-based technology programs.* Washington DC: ChemTechLinks.

American Chemical Society (ACS). (2006b, March). *Critical issues and effective practices in chemistry-based laboratory technology education.* (Report supported by the National Science Foundation, grant DUE 0053250). Washington DC: ChemTechLinks.

American Chemical Society (ACS). (2007, July). *Directory of chemistry-based technology programs.* Washington DC: ChemTechLinks.

American Chemical Society (ACS). (2008, July). *Directory of chemistry-based technology programs.* Washington DC: ChemTechLinks.

Anderson, A., & Kosarek, D. (1997). *Critical issues in the evolving relationship between business, industry, and postsecondary education* (National Coalition of Advanced Technology Centers Report Series Vol. 1, No. 4). Waco, TX: Center for Occupational Research and Development.

Aronson, B. (2008, Fall). Chemistry-Based technology programs receive ACS approval. *ConnecTech,* 11.

Aronson, B., & Wesemann J. (2007). Equipping the 2015 chemical technology workforce: Partnering with key stakeholders. *Journal of Chemical Education, 84*(3), 392-393.

Austin, J. (1999). *The collaboration challenge: Making the most of strategic alliances between nonprofits and corporations* (Working Paper No. 6). Harvard Business School, Social Enterprise Series.

Ayers, D. F. (2002). Mission priorities of community colleges in the southern United States. *Community College Review, 30*, 1-3. Retrieved March 5 2007, from http://www.findarticles.com/p/articles/mi_m0HCZ/is_3_30/ai_99115086

Bailey, T., Alfonso, M., Scott, M., & Leinbach, T. (2004, August). *Educational outcomes of postsecondary occupational students* (Brief No. 22). New York: Columbia University, Community College Research Center.

Bailey, T., Jenkins, D., & Leinbach, T. (2005, September). Graduation rates, student goals, and measuring community college effectiveness (Brief No. 28). New York: Columbia University, Community College Research Center.

Bailey, T., Matsuzuka, Y., Jacobs, J., Morest, V., & Hughes, K. (2004, March). *Institutionalization and sustainability of the National Science Foundation's advanced technological education program* (Brief No. 20). New York: Columbia University, Community College Research Center.

Banachowski, G. (1997). *Advantages and disadvantages of employing part-time faculty in community colleges.* Los Angeles: ERIC Clearinghouse for Community Colleges. (ERIC Document Reproduction Service No. ED 405037.

Beall H., & Berka, L. (1990). Report on the WPI-NEACT conference: "Perceptions of chemistry." *Journal of Chemical Education, 67*(2), 103-104.

Bennis, W., & Nanus, B. (2005). *Leaders strategies for taking charge.* New York: Collins Business Essentials.

Bradley, P. (2006). In technical education as enrollment grows, so does its scope. *Community College Week, 18*(12), 12-13.

Bragg, D. (1997). Grubb's case for compromise: Can "education through occupations" be more? *Journal of Vocational Education Research, 22*(2), 115-122.

Bragg, D. (2001). Community college access, mission, and outcomes: Considering intriguing intersections and challenges. *Peabody Journal of Education, 76*(1), 93-116.

Brand, B. (1997). *Community colleges and economic development.* (National Coalition of Advanced Technology Centers Report Series Vol. 1, No. 2). Waco, TX: Center for Occupational Research and Development.

Bredo, E., & Feinberg, W. (1982). *Knowledge and values in social and educational research.* Philadelphia: Temple University Press.

Brewer, E., & McMahan, J. (2004). Job stress and burnout among industrial and Technical educators. *Journal of Vocational Education Research*. Retrieved October 14, 2006 from http://scholar.lib.vt.edu/ejournals/JVER/v28n2/brewer.html

Brewer, E., & McMahan-Landers, J. (2003). Job satisfaction among industrial and technical teacher educators. *Journal of Industrial Teacher Education*. Retrieved October 15, 2006 from http://scholar.lib.vt.edu/ejournals/JITE/v40n2/brewer.html

Brown, B. (2000). *Vocational teacher professional development* (Practice Application Brief No. 11). Columbus, OH: ERIC Clearinghouse on Adult, Career, and Vocational Education. (ERIC Document Reproduction Service No. ED442994).

Campbell, T., & Slaughter, S. (1999). Faculty and administrator's attitudes toward potential conflicts of interest: Commitment and equity in university-industry relationships. *Journal of Higher Education, 70*(3), p 309-352.

Cochran, L.H., Phelps, L., & Cochran, L.L. (1980). *Advisory committees in action*. Boston: Allyn & Bacon.

Creswell, J. (2005). *Educational research* (2nd ed.). Upper Saddle River, NJ: Pearson Education.

Cuban, L. (2000). Fads and fireflies: The difficulties of sustaining change. *Educational Leadership, 57*(7), 7-9.

Dalton, L. W. (2004). Employment opportunities for 2004 and beyond. *Chemical and Engineering News, 82*(1), 39-46.

Delta College. (n.d.). *Chemical technology.* Retrieved March 5, 2007, from http://www.delta.edu/chm/chemtech1.htm

Dillman, D. (2007). *Mail and internet surveys*. Hoboken, NJ: Wiley

Dougherty, K., & Bakia, M. (2000). *The new economic development role of the community college*. (Brief No. 6). New York: Columbia University, Community College Research Center.

Drumm, P., Hinkle, A., & Quenzer, T. (2006, September). *The role and expectations of industry.* Panel discussion at the meeting of the American Chemical Society on Equipping the 2015 Chemical Technology Workforce. San Francisco.

Eisen, P. (1997). It all depends on you: A manufacturer's perspective on community colleges. *Community College Journal, 67*(6), 19-22.

Engelman, J. (2004). We've come a long way. *Chemical and Engineering News, 82*(30), 47.

Engelman, J. (2005). A strategic focus on chemical technicians, *Chemical and Engineering News, 83*(14), 72.

Erwin, J. (2005). Caterpillar Inc.'s think big program at Illinois Central College: Sustaining financial support through collaborative partnerships. *New Directions for Community Colleges, 132*, 59-65.

Executive summary. (2006, October). *ATE Impact Home Page.* From the National Science Foundation's principal investigator's conference, Washington D.C. Retrieved February 23, 2007, from http://www.atecenters.org

Farmer, E., & Watba, U. (2006). Challenges confronting community college deans, *Community College Journal of Research and Practice, 30*(3), 243-251.

Fields, A. (2005). *Factor analysis using SPSS*. Retrieved October 1, 2008 from http://www.sussex.ac.uk/Users/andyf/factor.pdf

Florida Department of Education (2006, July). *Curriculum framework for chemical technology.* Retrieved March 5, 2007, from http://www.fldoe.org/cc/mindsToWork/administrative_documents/ind_pdf/0641030100.pdf

Frame, K., Leaym, T., Millspaugh, K., & Wickham M. (2006, September). *The role and expectations of professional societies*. Panel discussion at the meeting of the American Chemical Society on Equipping the 2015 Chemical Technology Workforce. San Francisco.

Frenzel, L. (2003). *The disappearing associate degree program in electronics technology*. Paper presented at the 2003 American Society for engineering Education Annual Conference & Exposition.

Friedman, D., Marine, S., & Neils, T. (2006, September). *The role and expectations of academia*. Panel discussion at the meeting of the American Chemical Society on Equipping the 2015 Chemical Technology Workforce. San Francisco.

Gappa, J. & Leslie, D. (1993). *The invisible faculty*. San Francisco: Jossey-Bass.

Gibbs, H. (2005). A relationship with great chemistry. *Techniques*, *80*(3), 28-35.

Good, R., Killian, B., Marine, S., Neils, T., & Singer, J. (2006, August). *Partnering to prepare the 2015 technician workforce: Building successful partnerships.* Panel discussion at the 19th Biennial Conference on Chemical Education. Purdue University.

Goodland, R. (2002). Sustainability: Human social, economic and environmental. In P. Timmerman & the faculty of environmental studies, York University (Eds.), *Social and economic dimensions of global change: Vol. 5. Encyclopedia of global environmental change*. Hoboken, NJ: Wiley.

Grubb, W. N. (1997). Not there yet: Prospects and problems for "education through occupations." *Journal of Vocational Education Research, 22*(2), 77-94.

Grubb, W. N. (1999a). Edging toward effectiveness: Examining postsecondary occupational education. *National Assessment of Vocational Education.* Retrieved November 22, 2006 from http://www.ed.gov/rschstat/eval/sectech/nave/grubbi.html

Grubb, W. N. (1999b). From isolation to integration: Occupational education and the emerging systems of workforce development. *National Center for Research in Vocational Education: Centerpoint, 3*. Retrieved May 19, 2007, from http://ncrve.berkeley.edu/CenterPoint/CP3/CP3.html

Grubb, W. N. (2002). Learning and earning in the middle, part I: National studies of pre-baccalaureate education. *Economics of Education Review 21*(4), 299-321.

Grubb, W., Worthen, H., Buyd, B., Webb, E., Badway, N., Case, C., et al. (1999). *Honored but invisible; An inside look at teaching in community college.* New York: Routledge.

Gruber, D. (2000, January). We're education . . . you're semiconductors. *Working Ventures.* Retrieved January 15, 2007, from http://www.ppv.org/ppv/publications/assets/98_publication.pdf

Guba, E., & Lincoln, Y. (1994). Competing paradigms in qualitative research. In N.K. Denzin & Y.S.Lincoln (Eds.) *Handbook of qualitative research*. Thousand Oaks, CA: Sage.

Harmon, R., & MacAllum, K. (2003). *Documented characteristics of labor market-responsive community colleges and review of supporting literature*. Washington, DC: Department of Education.

Healy, M., & Perry, C. (2000). Comprehensive criteria to judge validity and reliability of qualitative research within the realism paradigm. *Qualitative Market Research – An International Journal*, *3*(3), 118-126.

Jacobs, J. (2001). What is the future of post-secondary occupational education? *Journal of Vocational Education Research, 26*(2), 172-205.

Jacobs, J., & Voorhees, R. (2006). The community college as a nexus for workforce transitions: A critical essay. *Journal of Applied Research in the Community College, 13*(2), 133-139.

Joint Committee on Standards for Educational and Psychological Research and Testing. (1999). *Standards for Educational and Psychological Testing.* Washington, DC: American Educational Research Association.

Kenkel, J. (1990). Chemistry technician training: A formula for success. *Journal of College Science Teaching, 19*(2), 381-385.

Kenkel, J. (1997). A university president's perspective on recruitment, retention, and quality. *Journal of Chemical Education, 74*(4), 377-378.

Kisner, M. J., Mazza, M. J., & Liggett, D. R. (1997). Building partnerships. *New Directions for Community Colleges, 97*, 23-28.

Krauss, S. (2005). Research paradigms and meaning making: A primer. *The Qualitative Report, 10*(4), 758-770.

Krueger, B. A. (2005). Qualitative assessment of a community college/business partnership: BNSF railroad dispatcher training program at Tarrant County College (Texas). *Dissertation Abstracts International, 66*(05A), 1581.

Lankard, B. A. (1993). *Part-time instructors in adult and vocational education.* Columbus, OH: ERIC Clearinghouse on Adult, Career, and Vocational Education. (ERIC Document Reproduction Service No. ED36797).

Lawrenz, F., & Keiser N. (2001). *Sustainability: Increasing the likelihood of a long-term impact by the ATE program*. Kalamazoo, MI: Western Michigan University, The Evaluation Center.

Lawrenz, F., Keiser, N., & Lavoie, B. (2003). Sustaining innovation in technological education. *Community College Review, 30*(4), 47.

Lederer, J. E. (2005). *Promoting lifelong learning: An analysis of community college delivery of employer-focused education and training*. Unpublished doctoral dissertation, University of Washington, Seattle.

Lohman, E. M., & Dingerson, M. R. (2005). The effectiveness of occupational-technical certificate programs: Assessing student career goals. *Community College Journal of Research and Practice, 29*(5), 339-355.

MacAllum, K., & Yoder, K. (2004). *The 21st-century community college: A strategic guide to maximizing labor market responsiveness.* A report prepared for the Office of Vocational and Adult Education. Washington, DC: Academy for Educational Development.

Mahoney, J., & Barnett, L. (2000). *The learning edge*. Washington DC: Community College Press.

Marasco, C. (2005). Technicians craft a promising future. *Chemical and Engineering News, 83*(45), 49-50.

Maurer, M. (2000). *Professional development in career and technical education* (Brief No. 7). Columbus, OH: National Dissemination Center for Career & Technical Education.

Moore, M. (2008, Fall). What is a chemical technician? *ConnecTech*, 3-4.

Nardi, P. (2006). *Doing survey research* (2nd ed). Boston: Pearson Education.

National Science Foundation (NSF). (2006, October). *ATE centers impact 2006-2007.* Retrieved February 23, 2007, from http://www.atecenters.org

Nietzsche, F. (1965). “Nachlass”, in A Danto, *Nietzsche as Philosopher*, New York: MacMillan.

Oregon Department of Education. (2006). *2005-2006 consolidated annual report: State of Oregon*. Retrieved December 22, 2006 from http://www.ode.state.or.us/teachlearn/pte/2005_2006carnarrative.pdf

Partnership for the Advancement of Chemical Technology (PACT), (n.d.). *General marketing plan for chemical technology degree programs.* Retrieved January 2, 2007 from http://www.terrificscience.org/programs/pact/pdfs/gen_marketing_plan.pdf

Perez, S. (2007). All aboard for online collaboration project SAIL: Specialty Asynchronous Industry Learning. *Leadership Abstracts*, *20*(1). Retrieved February 1, 2007, from http://www.league.org/publication/leadership/issue.cfm

Phillips, D., & Burbules, N. (2000). *Postpositivism and educational research*. Lantham, MD: Rowman & Littlefield.

Raley, B. (2000). The international alliance for process technology: A partnership for America's future. *Community College Journal of Research and Practice, 24*(1), 37-46.

Rice University (n.d.). Waste disposal. Retrieved April 26, 2009, from http://safety.rice.edu/waste%20disposal.htm

Rickey, T. (1999, Spring). Chemical technicians. *Chemistry*, 6-7.

Roueche, J., Roueche, S., & Milliron, M. (1995) *Strangers in their own land: Part-time faculty in American community colleges*. Washington, DC: The Community College Press.

Ruhland, S. (2001). Factors that influence the turnover and retention of Minnesota's technical college teachers. *Journal of Vocational Education Research, 26*(1), 56-76.

SCANS (1991). What work requires of schools: A SCANS report for America 2000. Washington, DC: U.S. Department of Labor.

Scheirer, M. A. (2005). Is sustainability possible? A review and commentary on empirical studies of program sustainability. *American Journal of Evaluation*. *26*(3), 320-347.

Schmidt, K. (1998). A comparative study of two delivery mechanisms of dual vocational training in Germany: Implications for vocational training in the United States. *Journal of Industrial Teacher Education, 35*(3), 24-43.

Schutt, R. (2004). *Investigating the social world: The process and practice of research* (4th ed.). Boston: Pine Forge Press.

Settle, F. (2000). The 21st century chemical technician workforce. *American Laboratory*, *32*(18), 6-10. Retrieved March 5, 2007, from http://www.iscpubs.com/articles/al/a0009set.pdf

Shediac-Rizkallah, M., & Bone, L. (1998). Planning for the sustainability of community-based health programs: Conceptual frameworks and future directions for research, practice and policy. *Health Education Research, 13*(1), 87-108.

Shubird, E. (1990). *Developing a promotional plan for adult vocational programs.* Montgomery, AL: Alabama State Department of Education, Division of Vocational Education Services.

Skolits, G., & Graybeal, S. (2007). Community college institutional effectiveness. *Community College Review, 34*(4), 302-323.

Spangler, M. (2002). Concluding observations on successful partnerships. *New Directions for Community Colleges*, *119*, 77-80.

Stander, A, Schalinske, R., & Sarquis, A. (2000). *PACT research profile study: Chemical technology student, instructor, and practicing technician survey report, partnership for the advancement of chemical technology*. Middleton, OH: Miami University Middletown, Center for Chemistry Education.

StatSoft (2004). Cluster analysis. Retrieved May 12, 2007, from http://www.statsoft.com/textbook/stcluan.html

Sundberg, L. (2002). Building partnerships with business that make a difference. *New Directions for Community Colleges*, *119*, 13-20.

Trochim, W. (2006). Positivism and post-positivism. *Research Methods Knowledge Base*. Retrieved January 30, 2007, from http://www.socialresearchmethods.net/kb/positvsm.php

Turcott, F. (1990). *1990-1991 Marketing plan. Year II: Planning to meet the future.* Catonsville, MD: Catonsville Community College, Office of Institutional Research.

U.S. Department of Labor (2008). Occupational outlook handbook. *Bureau of Labor Statistics*. Retrieved January 1, 2009 from http://www.bls.gov/oco/ocos115.htm#emply

United Nations Educational, Scientific and Cultural Organization. (2002). *Technical and vocational education and training for the twenty-first century.* Paris, France: Author.

Vars, G., & Beane, J. (2000). *Integrative curriculum in a standards-based world.* Champaign, IL: ERIC Clearinghouse on Elementary and Early Childhood Education. (ERIC Document Reproduction Service No. ED44618).

Vaughan, G. B., & Associates (Eds.). (1992). *Dilemmas of leadership: Decision making and ethics in the community college*. San Francisco: Jossey-Bass.

Vogt, W. (2007). *Quantitative research methods for professionals*. Boston: Pearson Education.

Wallin, D. (2004). Valuing professional colleagues: Adjunct faculty in community and technical colleges. *Community College Journal of Research and Practice, 28*(4), 373-391.

Warford, L., & Flynn, W. (2000). New game, new rules: The workforce development challenge. *Leadership Abstracts, 13*(2), 1-5. Retrieved January 10, 2007 from http://www.league.org/publication/leadership

Wilhelms, C. (2001, Winter). Review of implementation of non-credit certificate programs in the comprehensive community college mission, *The Catalyst*. Retrieved May 15, 2007, from http://findarticles.com/p/articles/mi_qa4011/is_200101/ai_n8931753

Willett, T., & Luan, J. (2000). Measuring employment success and occupational program satisfaction. Aptos, CA: Cabrillo College.

York, L. (1995). Building unique partnerships: Perceived effectiveness of contract training offered by a public comprehensive community college, (Doctoral dissertation, The University of Texas at Austin, 1995). *Dissertation Abstracts International*, *57,* 233.

Youngs, H. (2007). Having the 'presence' and courage to see beyond the familiar: Challenging our habitual assumptions of school leadership. In *Proceedings of the 2007 ACEL and ASCD International Conference: New imagery for schools and schooling: Challenging, creating and connecting* (pp. 1-12). Sydney: Australian Council of Educational Leaders.

Zammito, J., (2004). *A nice derangement of epistemes*. The University of Chicago Press: Chicago and London.

Zinser, R. (2003). Evaluation of a community college technical program by local industry. *Journal of Industrial Teacher Education. 40*(2). Retrieved March 5, 2007, from http://scholar.lib.vt.edu/ejournals/JITE/v40n2/zinser.html

Zinser, R., & Lawrenz, F. (2004). New roles to meet industry needs: A look at the advanced technological education program. *Journal of Vocational Education Research, 29*, 1-16. Retrieved August 24, 2006, from http://scholar.lib.vt.edu/ejournals/JVER/v29n2/zinser.html

Zmetana, K. (n.d.). Leadership. *New Designs for Career and Technical Training Design Review No. 77.* Retrieved April 20, 2006, from http://newdesigns.oregonstate.edu/compendium/Staffing/design77.htm

APPENDICES

Appendix A: Survey Instrument

Chemistry-Based Technology Training Programs: Survey Questionnaire

There are eight pages to this questionnaire. Part I of this questionnaire includes general questions about your program and your opinion of your program's sustainability. Part II will ask for ratings of factors related to the sustainability of chemistry-based technology training (CBTT) programs as well as an overall ranking of the importance of factors to sustainability. This ratings section is organized according to the following four general categories related to the sustainability of chemistry-based technology training programs: (1) Partnerships, (2) Employer and student educational goals, (3) Faculty and their resources, and (4) Community perception and marketing strategies. The questions pertaining to each of the categories are preceded by definitions which apply to each factor's relationship to program sustainability. Part three of the questionnaire will ask you to rank the four general categories in order of importance. Finally part four will ask an open-ended question regarding other factors you feel are important.

Part 1: General information.

College:

Name:

☐ Full-time faculty ☐ Part-time faculty ☐ Administrator

Which of the following best describes your program?

☐ chemical laboratory ☐ chemical process ☐ biotechnology

☐ environmental technology ☐ other (please specify)

1. Is your program currently active?
2. If active, how long has your program been in existence?
3. How many students are currently enrolled in your program?
4. How would you characterize the future demand for technicians from your program? ☐ high ☐ moderate ☐ low ☐ uncertain

Appendix A Continued

Sustainability is defined as: *"Continued program activities with observable benefits or outcomes for stakeholders,"* where stakeholders are students, the college, and employers. Please consider the following statement and indicate the number that best describes your opinion.

5. The chemistry-based technology training program at our college is highly sustainable. ☐ strongly agree ☐ agree ☐ neither agree nor disagree ☐ disagree ☐ strongly disagree

TO THE SURVEY PARTICIPANT: When responding to the statements in Part II, please give your rating in the context of your program's current sustainability. If your program is no longer in operation, please complete the survey with respect to the final year(s) of its existence.

Part II: Ratings of factors related to the sustainability of chemistry-based technology training programs.

Using the definitions of "sustainability" and "partnerships" given below, please respond to statements 1-9 by indicating the number that best describes your opinion.

Program sustainability is defined as *"Continued program activities with observable benefits or outcomes for stakeholders."*

Partnerships are defined as *"Cooperative efforts or agreements between community colleges and business and industry to pool resources for mutually acceptable purposes in CBTT programs."*

Appendix A Continued

1. Our CBTT program has a high degree of partnering with business and industry.

☐ strongly agree ☐ agree ☐ neither agree nor disagree

☐ disagree ☐ strongly disagree

2. Our college has been highly responsive to the training needs of business and industry.

☐ strongly agree ☐ agree ☐ neither agree nor disagree

☐ disagree ☐ strongly disagree

3. Our college administration has been extremely active/influential in promoting partnerships with business and industry.

☐ strongly agree ☐ agree ☐ neither agree nor disagree

☐ disagree ☐ strongly disagree

4. Our college president is very involved in the strengthening of the effectiveness of partnerships with business and industry.

☐ strongly agree ☐ agree ☐ neither agree nor disagree

☐ disagree ☐ strongly disagree

5. Differences in education and training philosophies between our college and business and industry have not affected the sustainability of our CBTT program.

☐ strongly agree ☐ agree ☐ neither agree nor disagree

☐ disagree ☐ strongly disagree

Appendix A Continued

6. Differences in administrative styles between our college and business and industry have not affected the sustainability of our CBTT program.

☐ strongly agree ☐ agree ☐ neither agree nor disagree

☐ disagree ☐ strongly disagree

7. Ethical differences between our college and business and industry have not affected the sustainability of our CBTT program.

☐ strongly agree ☐ agree ☐ neither agree nor disagree

☐ disagree ☐ strongly disagree

8. Our CBTT program provides considerable experiential learning opportunities, such as internships or multi-venue training.

☐ strongly agree ☐ agree ☐ neither agree nor disagree

☐ disagree ☐ strongly disagree

9. Employer input in the development of CBTT program curricula has been extensive.

☐ strongly agree ☐ agree ☐ neither agree nor disagree

☐ disagree ☐ strongly disagree

Using the definitions of "sustainability" and "employer and student educational goals" given below, please respond to statements 10-16 by indicating the number that best describes your opinion.

Program sustainability is defined as *"Continued program activities with observable benefits or outcomes for stakeholders."*

Employer and student educational goals are defined as *"Common educational objectives of employers and students that are related to employability skills and job attainment."*

APPENDIX A Continued

10. The use of job skill standards developed by regional industries, state labor boards, or professional organizations has been an essential component of our CBTT program.

☐ strongly agree ☐ agree ☐ neither agree nor disagree

☐ disagree ☐ strongly disagree

11. The use of guidelines established by the American Chemical Society's ChemTechLinks' Skill Standards has been an essential component of our CBTT program.

☐ strongly agree ☐ agree ☐ neither agree nor disagree

☐ disagree ☐ strongly disagree

12. Student education and training in employability skills such as adaptability, teamwork, problem-solving, and effective communication, are thoroughly integrated into our CBTT program.

☐ strongly agree ☐ agree ☐ neither agree nor disagree

☐ disagree ☐ strongly disagree

13. The number of students completing our program, through certification and/or associate's degree, strongly influences the sustainability of our CBTT program.

☐ strongly agree ☐ agree ☐ neither agree nor disagree

☐ disagree ☐ strongly disagree

14. Business and industry's hiring of CBTT program participants prior to completing the certificate or degree has not affected our CBTT program sustainability.

☐ strongly agree ☐ agree ☐ neither agree nor disagree

☐ disagree ☐ strongly disagree

Appendix A Continued

15. Our CBTT program students have a high degree of job placement in the related industry. ☐ strongly agree ☐ agree ☐ neither agree nor disagree ☐ disagree ☐ strongly disagree

16. Students in our program are able to seamlessly transfer most CBTT program course credits to regional four-year colleges and/or continuing education toward a Bachelor's degree. ☐ strongly agree ☐ agree ☐ neither agree nor disagree ☐ disagree ☐ strongly disagree

Using the definitions of "sustainability" and "faculty and their resources" given below, please respond to statements 17-27 by indicating the number that best describes your opinion. Program sustainability is defined as *"Continued program activities with observable benefits or outcomes for stakeholders."*

Faculty and their resources are defined as *"Chemistry-based technology training program instructors and the supporting instructional resources available from the college, business and industry, and/or community."*

17. Obtaining and retaining full- and part-time faculty has never been an issue in our CBTT program. ☐ strongly agree ☐ agree ☐ neither agree nor disagree ☐ disagree ☐ strongly disagree

18. The use of part-time faculty has never been an issue in the quality of instruction in our CBTT program. ☐ strongly agree ☐ agree ☐ neither agree nor disagree ☐ disagree ☐ strongly disagree

Appendix A Continued

19. Our college provides an abundance of professional development opportunities for our CBTT program faculty. ☐ strongly agree ☐ agree ☐ neither agree nor disagree ☐ disagree ☐ strongly disagree

20. Our CBTT program's sustainability is affected by excessive faculty workloads. ☐ strongly agree ☐ agree ☐ neither agree nor disagree ☐ disagree ☐ strongly disagree

21. The funding provided by our college for equipment and instrumentation has been completely adequate for our CBTT program. ☐ strongly agree ☐ agree ☐ neither agree nor disagree ☐ disagree ☐ strongly disagree

22. The funding provided by our college for laboratory facilities has strongly supported the needs of our CBTT program participants. ☐ strongly agree ☐ agree ☐ neither agree nor disagree ☐ disagree ☐ strongly disagree

23. Funding and other resources, including instrumentation and equipment, provided by sources outside the college, have continued to support the sustainability of our CBTT program. ☐ strongly agree ☐ agree ☐ neither agree nor disagree ☐ disagree ☐ strongly disagree

Appendix A continued

24. The funding provided by our college for faculty positions in our CBTT program is completely adequate.

☐ strongly agree ☐ agree ☐ neither agree nor disagree

☐ disagree ☐ strongly disagree

25. College administrators have strongly supported our CBTT program instructors through their encouragement in morale building and job satisfaction.

☐ strongly agree ☐ agree ☐ neither agree nor disagree

☐ disagree ☐ strongly disagree

26. A champion is a leader that effectively advocates for support of the program and its partnerships. Our program has a "champion" from the college who has greatly contributed to the leadership and support of our CBTT program.

☐ strongly agree ☐ agree ☐ neither agree nor disagree

☐ disagree ☐ strongly disagree

27. Flexible scheduling by our college has resulted in improved educational opportunities for our CBTT program students.

☐ strongly agree ☐ agree ☐ neither agree nor disagree

☐ disagree ☐ strongly disagree

Using the definitions of "sustainability" and "community perception and marketing strategy" given below, please respond to statements 28-31 by indicating the number that best describes your opinion.

Program sustainability is defined as *"Continued program activities with observable benefits or outcomes for stakeholders."*

Appendix A Continued

Community perception is defined as *"Community awareness and attitudes toward CBTT programs,"* and marketing strategy is defined as *"Implementation of a comprehensive plan to attract and enroll students in CBTT programs."*

28. Our CBTT program is highly visible to prospective students in our community. ☐ strongly agree ☐ agree ☐ neither agree nor disagree ☐ disagree ☐ strongly disagree

29. Our community's perception of the chemistry-based technician profession is very positive. ☐ strongly agree ☐ agree ☐ neither agree nor disagree ☐ disagree ☐ strongly disagree

30. Our college has an excellent marketing plan that has positively contributed to the enrollment of students in our CBTT program. ☐ strongly agree ☐ agree ☐ neither agree nor disagree ☐ disagree ☐ strongly disagree

31. Our college actively promotes/markets our CBTT program to local secondary school students. ☐ strongly agree ☐ agree ☐ neither agree nor disagree ☐ disagree ☐ strongly disagree

Appendix A continued

Part III. **Rankings of the four general categories.** Please consider the significant aspects of your program and rank the following general factors (1-4 with 4 being the most important) in order of their importance to the sustainability of your CBTT program.

Partnerships
Employer and student educational goals
Faculty and their resources
Community perception and marketing strategy

Part IV: In addition to the factors considered in this survey, what other factors do you feel are important to the sustainability of your chemistry-based technology training program?

Appendix B: Institutional Study Letter of Introduction

OSU Oregon State UNIVERSITY

Adult Education & Higher Education Leadership
Oregon State University, College of Education, 403 Education Hall, Corvallis, OR 97331
Phone 541-737-4317 **Fax** 541-737-3655 www.oregonstate.edu/education

Dear Colleague:

Your name was obtained from the Directory of Chemistry-Based Technology Programs (July 2007) as the contact person for your college's chemical technology program. I'm writing to ask for your assistance in a research survey that concerns chemical technician training. The results of the survey will be presented in a dissertation that fulfills a partial requirement for the Ph.D. degree in Education with an emphasis in community college leadership at Oregon State University.

My interest in chemical technician training comes from being a community college instructor of chemistry as well as participation in a chemical technology training program. Additionally, my college is very interested in establishing a chemical technician training program.

Identifying and confronting the critical issues of chemistry-based laboratory technology programs is vital to their success. Recent published reports of these issues and effective practices, along with discussions at national conferences, verify this perspective. Through the ChemTechLinks conference (2004) and subsequent survey, several critical issues were identified by the ACS. Through my research, I intend to achieve additional insight into these issues by analyzing their roles and interrelationships in sustaining chemical technology programs.

I would greatly appreciate it if you would provide me with the names and addresses of two administrators and two faculty members who are actively involved in your program. Also, please indicate if you are willing to participate in the survey as one of the four individuals from your college. I will contact the individuals and ask for their participation in my study. If, for some reason, they are not available to participate, I ask your indulgence in requesting additional names.

Thank you very much for your support of my research.

Sincerely,

Bridgid A. Backus
Chemistry Instructor
Linn-Benton Community College
Albany, OR 97321

Appendix B Continued

Adult Education & Higher Education Leadership
Oregon State University, College of Education, 403 Education Hall, Corvallis, OR 97331
Phone 541-737-4317 **Fax** 541-737-3655 www.oregonstate.edu/education

Dear Colleague:

Your name was obtained from the contact person of your college listed in the Directory of Chemistry-Based Technology Programs (July 2007). I am requesting your participation in a research study involving the sustainability of chemistry-based technician training programs. The results of the survey will be presented in a dissertation that fulfills a partial requirement for the Ph.D. degree in Education with an emphasis in community college leadership at Oregon State University.

My interest in chemical technician training comes from being a community college instructor of chemistry as well as participation in a chemical technology training program. Additionally, my college is interested in establishing a chemical technician training program.

Identifying and confronting the critical issues of chemistry-based laboratory technology programs is vital to their success. Recent published reports of these issues and effective practices, along with discussions at national conferences, verify this perspective. As part of a doctoral dissertation, my goal is to achieve additional insight into these issues by analyzing their roles and interrelationships in sustaining chemical technology training programs.

I would greatly appreciate it if you would take a few minutes to answer a few questions and give your observations and opinions in a questionnaire. Your responses are very important. They will be kept confidential and your identity will not be disclosed. If you are willing to participate in this study, please reply by return e-mail. Please indicate if you would like to receive a hard or electronic copy of the questionnaire. Thank you very much.

Sincerely,

Bridgid A. Backus
Chemistry Instructor
Linn-Benton Community College
Albany, OR

Appendix C: Faculty and Administrator Participants–Informed Consent Document

Adult Education & Higher Education Leadership
Oregon State University, College of Education, 403 Education Hall, Corvallis, OR 97331
Phone 541-737-4317 **Fax** 541-737-3655 www.oregonstate.edu/education

INFORMED CONSENT DOCUMENT

Project Title: **Factors Related to the Economic Sustainability of Community College Chemistry-Based Technician Training Programs**
Principal Investigator: **Dr. Darlene Russ-Eft, School of Education, OSU**
Co-Investigator(s): **Bridgid Backus, Doctoral Student, OSU**

Dear (Prospective Participant):

As a faculty member or administrator connected with a Chemistry-Based Technical Training (CBTT) Program, you are being invited to take part in a research study as part of a doctoral thesis. The study is designed to determine the most significant factors associated with CBTT program sustainability. It will provide focus and direction for community college personnel and business leaders toward the improvement of their CBTT training programs. The primary use of the research is a doctoral thesis. The research findings and conclusions may be submitted for publication in professional journals and presented at professional conferences and meetings.

There are three research questions in this study: (a) What is the relative importance of the identified factors relating to economic sustainability of CBTT programs?, (b) What are the interrelationships among the factors related to the economic sustainability of CBTT programs?, and (c) What differences exist between the opinions of administrators and faculty with regard to the factors associated with CBTT program sustainability?

We are studying this topic in order to identify, examine, and analyze the most significant factors associated with economic sustainability of chemistry-based technician training (CBTT) programs in community colleges. The significance of this study for the community college community is based on four reasons: (a) There is a substantial need for chemical technician training and the demand for these workers is increasing; (b) community colleges play a prominent role in providing professional technical training; (c) professional organizations have expressed a need for research into the factors that have an impact on professional technical and CBTT program

Appendix C Continued

sustainability; and (d) there is a scarcity of data on factors relating to CBTT program sustainability.

We would appreciate it if you would take about 20 minutes to respond to the attached questionnaire and return it to my email address: backusb@linnbenton.edu. Your responses will be added together with others and recorded as a group. If the results of this project are published your identity will not be made public. **Your participation in this study is voluntary and you may refuse to answer any question(s) for any reason.** Only a small sample of individuals affiliated with CBTT programs will receive the questionnaire, so your participation is important to this study.

The answers you provide will be kept confidential to the extent permitted by law. Special precautions have been established to protect the confidentiality of your responses. The number on your questionnaire will be removed once it has been received. (The number is used to contact those who have not returned their questionnaire, so those who have responded are not burdened with additional mailings.) If you do not want to participate and do not wish to be contacted further, please return the uncompleted survey to the email address provided. Your questionnaire will be destroyed once your responses have been tallied. There are no foreseeable risks to you as a participant in this project; nor are there any direct benefits. However, your participation is extremely valued.

If you have any questions about the survey, please contact me at (541) 917-4625 or by email at backusb@linnbenton.edu. You may also contact the principal investigator, Darlene Russ-Eft at (541) 737-9373 or by email at darlene.russeft@oregon.edu. If you have questions about your rights as a participant in this research project, please contact the Oregon State University Institutional Review Board (IRB) Human Protections Administrator at (541) 737-4933 or by email at IRB@oregonstate.edu.

Thank you for your help. I appreciate your cooperation.

Sincerely,

Bridgid A. Backus
Chemistry Instructor
Linn-Benton Community College
Albany, OR

Appendix D: Participating Programs

Alabama Southern Community College (AL)
Alvin Community College (TX)
Amarillo College (TX)
Ashland Community and Technical College (KY)
Athens Technical College (GA)
Augusta Technical College (GA)
Baton Rouge Community College (LA)
Bellingham Technical College (WA)
Bidwell Training Center (PA)
Bismarck State College (ND)
Brazosport College (TX)
Caldwell Community College (NC)
Calhoun Community College (AL)
Cape Fear Community College (NC)
Community College of Philadelphia (PA)
Central Carolina Community College (NC)
Cincinnati State Technical and Community College (OH)
College of the Mainland (TX)
Colorado Northwestern Community College (CO)
County College of Morris (NJ)
Cuyahoga Community College (OH)
Del Mar College (TX)
Delaware Technical and Community College (DE)
Delta College (MI) Chem Process
Delta College (MI) Chem Lab
Edmonds Community College (WA)
Florence-Darlington Technical College (SC)
Grand Rapids Community College (MI)
Gwinnett Technical College (GA)
Houston Community College (TX)
Indian Hills Community College (IA)
Joliet Junior College (IL)
Lansing Community College (MI)
Leeward Community College (HI)
Los Angeles Harbor College (CA)
Los Angeles Technical College (CA)
Louisiana Delta Community College (LA)
MassBay Community College (MA)
Mercer County Community College (NJ)
Middlesex County College (NJ)
Millersville University (PA)
Mississippi Gulf Coast Community College (MS)
Monroe Community College (NY)

Appendix D Continued

Montgomery College (MD)
Mount San Antonio College (CA)
New York City College of Technology (NY)
North Georgia Technical College (GA)
Piedmont Community College (NC)
Red Rocks Community College (CO)
River Parishes Community College (LA)
Saint Paul College (MN)
San Diego Mesa College (CA)
San Jacinto College (TX)
Seattle Central Community College (WA)
South Arkansas Community College (AK)
Southeast Community College (NE)
Southwestern College (CA) Chem Lab
Saint Louis Community College (MO)
Texas State Technical College, Waco (TX)
The Victoria College (TX)
Tulsa Community College (OK)
Tulsa Technology Center (OK)
West Virginia State University (WV)

Appendix D Continued

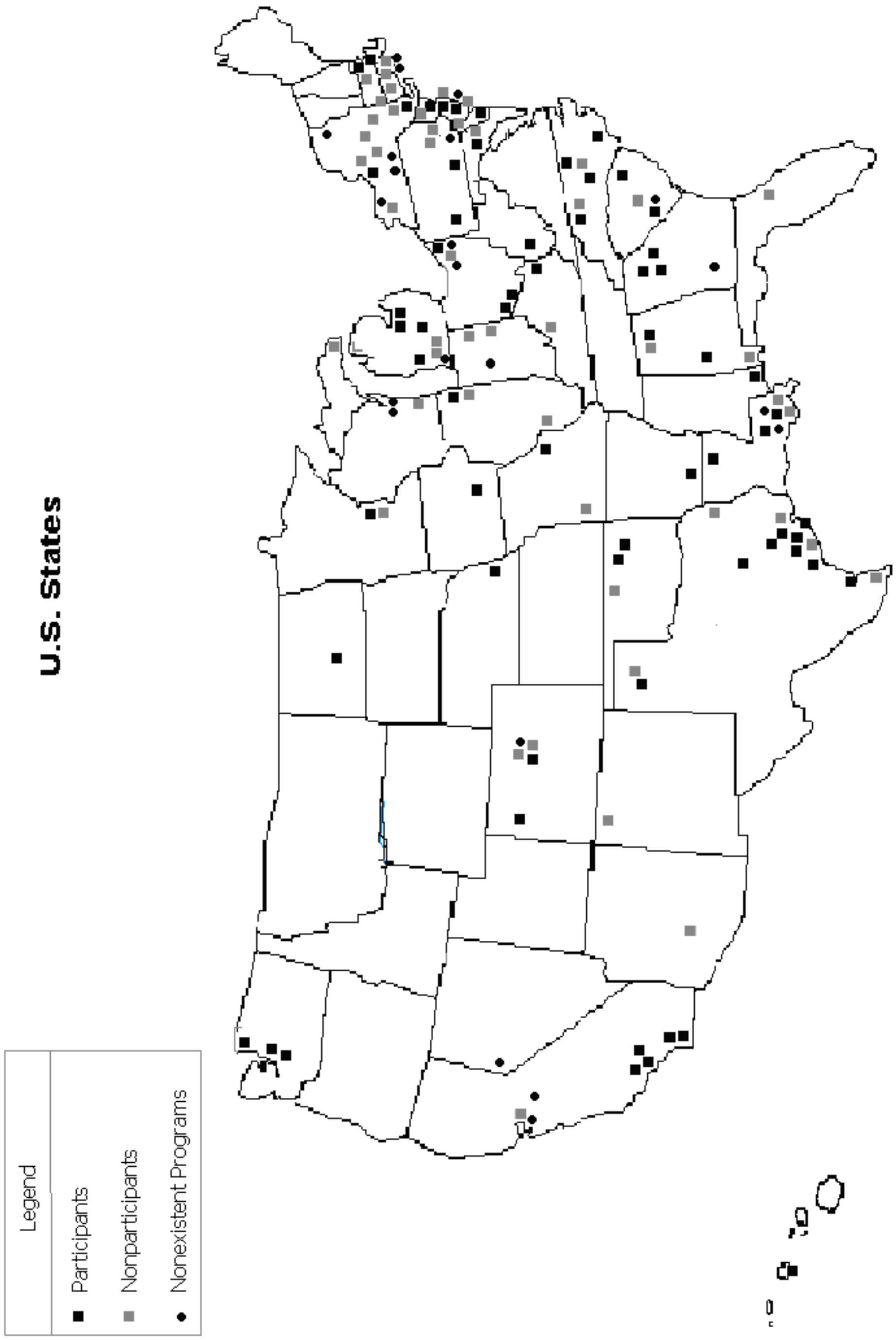

Figure: U.S. map illustrating participating, nonparticipating and nonexistent programs.

Appendix E: Summary of Participant Rankings of the Clustered Categories

Table E1: *Summary of Rankings of CBTT Program Participants of the Importance of Clustered Categories Relating to Sustainability*

	Rankings and Number of Participants			
Clustered Category	4	3	2	1
Partnerships	35	16	25	13
Employer and Student Educational Goals	23	28	20	18
Faculty and Their Resources	15	31	29	14
Community Perceptions and Marketing Strategy	16	14	15	44

N Valid 89
Missing 6

Table E2: *Summary of Rankings of CBTT Program Faculty and Administrators of the Importance of Clustered Categories Relating to Sustainability*

Clustered Category	4	3	2	1
Faculty				
Partnerships	24	10	21	7
Employer and Student Educational Goals	19	19	12	12
Faculty and Their Resources	10	24	18	10
Community Perceptions and Marketing Strategy	9	9	11	33
Administrators				
Partnerships	11	6	4	6
Employer and Student Educational Goals	4	9	2	1
Faculty and Their Resources	5	7	11	4
Community Perceptions and Marketing Strategy	7	5	4	11

N Valid 62 Faculty
27 Administrators
Missing 6

Appendix F: Summary of Descriptive Statistical Results of the Faculty and Administrators' Ratings

Data were collected and inserted into the tables below according to the positions of the participants. There were 29 administrators and 66 faculty that participated in the current study. The following is a summary of the percentages of the faculty and administrator ratings of their program's sustainability and the 31 Likert scale statements of the current study's survey.

Sustainability Statement: The CBTT program at our college is highly sustainable.

Summary of Participant Rating of Their Program's Sustainability

	Strongly Agee	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Percentage of Faculty	27.3%	48.5%	16.7%	6.1%	1.5%
Percentage of Administrators	41.4%	34.5%	10.3%	10.3%	3.4%

Statement 1: Our CBTT program has a high degree of partnering with business and industry.

Summary of Participant Ratings for Degree of Partnering

	Strongly Agee	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Percentage of Faculty	37.9%	42.4%	10.6%	6.1%	3.0%
Percentage of Administrators	48.3%	34.5%	3.4%	13.8%	0

Appendix F Continued

Statement 2: Our college has been highly responsive to the training needs of business and industry.

Summary of Participant Ratings for Responsiveness to Industry's Training Needs

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Percentage of Faculty	54.5%	36.4%	7.6%	1.5%	0
Percentage of Administrators	51.7%	34.5%	6.9%	6.9%	0

Statement 3: Our college administration has been extremely active/influential in promoting partnerships with business and industry.

Summary of Participant Ratings for Administration's Promotion of Partnerships

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Percentage of Faculty	30.3%	39.4%	15.2%	10.6%	4.5%
Percentage of Administrators	41.4%	37.9%	17.2%	3.4%	0

Statement 4: Our college president is very involved in the strengthening of the effectiveness of partnerships with business and industry.

Summary of Participant Ratings for President's Involvement in Partnerships

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Percentage of Faculty	25.8%	33.3%	30.3%	6.1%	4.5%
Percentage of Administrators	27.6%	48.3%	24.1%	0	0

Appendix F Continued

Statement 5: Differences in education and training philosophies between our college and business and industry have not affected the sustainability of our CBTT program.

Summary of Participant Ratings for Education and Training Philosophy Differences

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Percentage of Faculty	19.7%	45.5%	28.8%	6.1%	0
Percentage of Administrators	17.2%	55.2%	17.2%	10.3%	0

Statement 6: Differences in administrative styles between our college and business and industry have not affected the sustainability of our CBTT program.

Summary of Participant Ratings for Administrative Style Differences

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Percentage of Faculty	21.2%	37.9%	27.3%	12.1%	1.5
Percentage of Administrators	6.9%	65.5%	17.25	10.3%	0

Statement 7: Ethical differences between our college and business and industry have not affected the sustainability of our CBTT program.

Summary of Participant Ratings for Ethical Differences

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Percentage of Faculty	30.3%	39.4%	24.2%	6.1%	0
Percentage of Administrators	20.7%	62.1%	10.3%	6.9%	0

Appendix F Continued

Statement 8: Our CBTT program provides considerable experiential learning opportunities, such as internships or multi-venue training.

Summary of Participant Ratings for Experiential Learning Opportunities

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Percentage of Faculty	34.8%	42.4%	13.6%	7.6%	1.5%
Percentage of Administrators	34.5%	37.9%	13.8%	13.8%	0

Statement 9: Employer input in the development of CBTT program curricula has been extensive.

Summary of Participant Ratings for Employer Input in Curriculum Development

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Percentage of Faculty	36.4%	48.5%	10.6%	4.5%	0
Percentage of Administrators	62.1%	27.6%	6.9%	3.4%	0

Statement 10: The use of job skill standards developed by regional industries, state labor boards, or professional organizations has been an essential component of our CBTT program.

Summary of Participant Ratings for Job Skill Standards

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Percentage of Faculty	27.3%	48.5%	12.1%	9.1%	3.0%
Percentage of Administrators	48.3%	34.7%	10.3%	6.9%	0

Appendix F Continued

Statement 11: The use of guidelines established by the American Chemical Society's ChemTechLinks Skill Standards has been an essential component of our CBTT program.

Summary of Participant Ratings for ACS Skill Standards

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Percentage of Faculty	13.6%	21.2%	27.3%	24.2%	13.6%
Percentage of Administrators	20.7%	13.8%	37.9%	20.7%	6.9%

Statement 12: Student education and training in employability skills such as adaptability, teamwork, problem-solving, and effective communication, are thoroughly integrated into our CBTT program.

Summary of Participant Ratings for Employability Skills

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Percentage of Faculty	50.0%	39.4%	7.6%	1.5%	1.5%
Percentage of Administrators	44.8%	48.3%	3.4%	3.4%	0

Statement 13: The number of students completing our program, through certification and/or associate's degree strongly influences the sustainability of our CBTT program.

Summary of Participant Ratings for Number of Program Graduates

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Percentage of Faculty	36.4%	36.4%	21.2%	4.5%	1.2%
Percentage of Administrators	37.9%	58.6%	0	3.4%	0

Appendix F Continued

Statement 14: Business and industry's hiring of CBTT program participants prior to completing the certificate or degree has not affected our CBTT program sustainability.

Summary of Participant Ratings for Hiring Practices of Non-Graduates

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Percentage of Faculty	13.6%	40.9%	27.3%	13.6%	4.5%
Percentage of Administrators	3.4%	58.6%	10.3%	27.6%	0%

Statement 15: Our CBTT program students have a high degree of job placement in the chemical industry.

Summary of Participant Ratings for Degree of Student Job Placement

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Percentage of Faculty	37.9%	36.4%	18.2%	4.5%	3.0%
Percentage of Administrators	34.5%	48.3%	6.9%	10.3%	0

Statement 16: Students in our program are able to seamlessly transfer most CBTT program course credits to regional four-year colleges and/or continuing education toward a Bachelor's degree.

Summary of Participant Ratings for Transferability of Program Credits

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Percentage of Faculty	21.2%	34.8%	21.2%	12.1%	10.6%
Percentage of Administrators	20.7%	31.0%	10.3%	31.0%	6.9%

Appendix F Continued

Statement 17: Obtaining and retaining full- and part-time faculty has never been an issue in our CBTT program.

Summary of Participant Ratings for Obtaining and Retaining Faculty

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Percentage of Faculty	24.2%	30.3%	16.7%	22.7%	6.1%
Percentage of Administrators	10.3%	51.7%	3.4%	24.1%	10.3%

Statement 18: The use of part-time faculty has never been an issue in the quality of instruction in our CBTT program.

Summary of Participant Ratings for Quality Instruction and Use of Part-time Faculty

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Percentage of Faculty	21.5%	30.8%	26.2%	18.5%	3.1%
Percentage of Administrators	17.2%	37.9%	24.1%	20.7%	0

Statement 19: Our college provides an abundance of professional development opportunities for our CBTT program faculty.

Summary of Participant Ratings for Faculty Professional Development Opportunities

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Percentage of Faculty	10.6%	37.9%	24.2%	21.2%	6.1%
Percentage of Administrators	13.8%	24.1%	34.5%	27.6%	0

Appendix F Continued

Statement 20: Our CBTT program's sustainability is affected by excessive faculty workloads.

Summary of Participant Ratings for Excessive Faculty Workloads

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Percentage of Faculty	10.6%	34.8%	22.7%	25.8%	6.1%
Percentage of Administrators	0	10.3%	17.2%	62.1%	10.3%

Statement 21: The funding provided by our college for equipment and instrumentation has been completely adequate for our CBTT program.

Summary of Participant Ratings for Equipment and Instrumentation Funding

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Percentage of Faculty	15.2%	39.4%	9.1%	22.7%	13.6%
Percentage of Administrators	17.2%	31.0%	24.1%	24.1%	3.4%

Statement 22: The funding provided by our college for laboratory facilities has strongly supported the needs of our CBTT program participants.

Summary of Participant Ratings for Classroom and Laboratory Funding

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Percentage of Faculty	21.2%	30.3%	15.2%	28.8%	4.5%
Percentage of Administrators	20.7%	41.4%	13.8%	20.7%	3.4%

Appendix F Continued

Statement 23: Funding and other resources, including instrumentation and equipment, provided by sources outside the college, have continued to support the sustainability of our CBTT program.

Summary of Participant Ratings for Funding from Outside Sources

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Percentage of Faculty	28.8%	39.4%	22.7%	6.1%	3.0%
Percentage of Administrators	31.0%	55.2%	6.9%	6.9%	0

Statement 24: The funding provided by our college for faculty positions in our CBTT program is completely adequate.

Summary of Participant Ratings for Faculty Position Funding

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Percentage of Faculty	7.6%	28.8%	22.7%	37.9%	3.0%
Percentage of Administrators	10.3%	41.4%	34.5%	6.9%	6.9%

Statement 25: College administrators have strongly supported our CBTT program instructors through their encouragement in morale building and job satisfaction.

Summary of Participant Ratings for Administrative Emotional Support

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Percentage of Faculty	9.1%	33.3%	31.8%	19.7%	6.1%
Percentage of Administrators	24.1%	27.6%	37.9%	10.3%	0

Appendix F Continued

Statement 26: Our program has a “champion” from the college who has greatly contributed to the leadership and support of our CBTT program.

Summary of Participant Ratings for Presence of a Champion

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Percentage of Faculty	25.8%	47.0%	18.2%	6.1%	3.0%
Percentage of Administrators	37.9%	44.8%	13.8%	3.4%	0

Statement 27: Flexible scheduling by our college has resulted in improved educational opportunities for our CBTT program students.

Summary of Participant Ratings for Flexible Scheduling

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Percentage of Faculty	12.1%	42.4%	31.8%	10.6%	3.0%
Percentage of Administrators	27.6%	37.9%	24.1%	10.3%	0

Statement 28: Our CBTT program is highly visible to prospective students in our community.

Summary of Participant Ratings for Community Visibility of Program

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Percentage of Faculty	1.5%	36.4%	21.2%	30.3%	10.6%
Percentage of Administrators	17.2%	24.1%	20.7%	27.6%	10.3%

Appendix F Continued

Statement 29: Our community's perception of the chemistry-based technician profession is very positive.

Summary of Participant Ratings for Community Perception of the Profession

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Percentage of Faculty	3.0%	36.4%	45.5%	13.6%	1.5%
Percentage of Administrators	17.2%	34.5%	34.5%	13.8%	0

Statement 30: Our college has an excellent marketing plan that has positively contributed to the enrollment of students in our CBTT program.

Summary of Participant Ratings for College Marketing Plan

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Percentage of Faculty	1.5%	15.2%	34.8%	24.2%	24.2%
Percentage of Administrators	0	20.7%	37.9%	27.6%	13.8%

Statement 31: Our college actively promotes/markets our CBTT program to local secondary school students.

Summary of Participant Ratings for Program Promotion to Secondary Students

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Percentage of Faculty	7.6%	27.3%	24.2%	24.2%	16.7%
Percentage of Administrators	10.3%	37.9%	10.3%	31.0%	10.3%

Appendix G: Summary of Descriptive Statistical Results of the Participants' Ratings

Data were collected and inserted into the tables below. Small programs had 50 participants whereas large programs had 45 participants. Program size was based upon the median number of students currently enrolled; which was 35.

Sustainability Statement: The chemistry-based technology training program at our college is highly sustainable.

Summary of Participant Rating of Their Program's Sustainability

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Number of participants	30	42	14	7	2
Percentage of participants	31.6%	44.2%	14.7%	7.4%	2.1%
Percentage from Small Programs	12.0%	46.0%	24.0%	14.0%	4.0%
Percentage from Large Programs	53.3%	42.2%	4.4%	0	0

Statement 1: Our CBTT program has a high degree of partnering with business and industry.

Summary of Participant Ratings for Degree of Partnering

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Number of participants	39	38	8	8	2
Percentage of participants	41.1%	40.0%	8.4%	8.4%	2.1%
Percentage from Small Programs	28.0%	44.0%	12.0%	12.0%	4.0%
Percentage from Large Programs	55.6%	35.6%	4.4%	4.4%	0

Appendix G Continued

Statement 2: Our college has been highly responsive to the training needs of business and industry.

Summary of Participant Ratings for Responsiveness to Industry's Training Needs

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Number of participants	51	34	7	3	0
Percentage of participants	53.7%	35.8%	7.4%	3.2 %	0
Percentage from Small Programs	50.0%	40.0%	8.0%	2.0%	0
Percentage from Large Programs	57.8%	31.1%	6.7%	4.4%	0

Statement 3: Our college administration has been extremely active/influential in promoting partnerships with business and industry.

Summary of Participant Ratings for Administration's Promotion of Partnerships

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Number of participants	32	37	15	8	3
Percentage of participants	33.7 %	38.9%	15.8%	8.4%	3.2%
Percentage from Small Programs	28.0%	36.0%	18.0%	12.0%	6.0%
Percentage from Large Programs	40.0%	42.2%	13.3%	4.4	0

Appendix G Continued

Statement 4: Our college president is very involved in the strengthening of the effectiveness of partnerships with business and industry.

Summary of Participant Ratings for President's Involvement in Partnerships

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Number of participants	25	36	27	4	3
Percentage of participants	26.3%	37.9%	28.4%	4.2%	3.2%
Percentage from Small Programs	22.0%	38.0%	26.0%	8.0%	6.0%
Percentage from Large Programs	31.1%	37.8%	31.1%	0	0

Statement 5: Differences in education and training philosophies between our college and business and industry have not affected the sustainability of our CBTT program.

Summary of Participant Ratings for Education and Training Philosophy Differences

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Number of participants	18	46	24	7	0
Percentage of participants	18.9%	48.4%	25.3%	7.4%	0
Percentage from Small Programs	26.0%	40.0%	28.0%	6.0%	0
Percentage from Large Programs	11.1%	57.8%	22.2%	8.9%	0

Appendix G Continued

Statement 6: Differences in administrative styles between our college and business and industry have not affected the sustainability of our CBTT program.

Summary of Participant Ratings for Administrative Style Differences

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Number of participants	16	44	23	11	1
Percentage of participants	16.8%	46.3%	24.2%	11.6%	1.1%
Percentage from Small Programs	26.0%	38.0%	24.0%	10.0%	2.0%
Percentage from Large Programs	6.7%	55.6%	24.4%	13.3%	0

Statement 7: Ethical differences between our college and business and industry have not affected the sustainability of our CBTT program.

Summary of Participant Ratings for Ethical Differences

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Number of participants	26	44	19	6	0
Percentage of participants	27.4%	46.3%	20.0%	6.3%	0
Percentage from Small Programs	34.0%	38.0%	22.0%	6.0%	0
Percentage from Large Programs	20.0%	55.6%	17.8%	6.7%	0

Appendix G Continued

Statement 8: Our CBTT program provides considerable experiential learning opportunities, such as internships or multi-venue training.

Summary of Participant Ratings for Experiential Learning Opportunties

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Number of participants	33	39	13	9	1
Percentage of participants	34.7%	41.1%	13.7%	9.5%	1.1%
Percentage from Small Programs	32.0%	42.0%	12.0%	12.0%	2.0%
Percentage from Large Programs	37.8%	40.0%	15.6%	6.7%	0

Statement 9: Employer input in the development of CBTT program curricula has been extensive.

Summary of Participant Ratings for Employer Input in Curriculum Development

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Number of participants	42	40	9	4	0
Percentage of participants	44.2%	42.1%	9.5%	4.2%	0
Percentage from Small Programs	38.0%	46.0%	8.0%	8.0%	0
Percentage from Large Programs	51.1%	37.8%	11.1%	0	0

Appendix G Continued

Statement 10: The use of job skill standards developed by regional industries, state labor boards, or professional organizations has been an essential component of our CBTT program.

Summary of Participant Ratings for Job Skill Standards

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Number of participants	32	42	11	8	2
Percentage of participants	33.7%	44.2%	11.6%	8.4%	2.1%
Percentage from Small Programs	24.0%	52.0%	10.0%	12.0%	2.0%
Percentage from Large Programs	44.4%	35.6%	13.3%	4.4%	2.2%

Statement 11: The use of guidelines established by the American Chemical Society's ChemTechLinks Skill Standards has been an essential component of our CBTT program.

Summary of Participant Ratings for ACS Skill Standards

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Number of participants	15	18	29	22	11
Percentage of participants	15.8%	18.9%	30.5%	23.2%	11.6%
Percentage from Small Programs	20.0%	20.0%	24.0%	24.0%	12.0%
Percentage from Large Programs	11.1%	17.8%	37.8%	22.2%	11.1%

Appendix G Continued

Statement 12: Student education and training in employability skills such as adaptability, teamwork, problem-solving, and effective communication, are thoroughly integrated into our CBTT program.

Summary of Participant Ratings for Employability Skills

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Number of participants	46	40	6	2	1
Percentage of participants	48.4%	42.1%	6.3%	2.1%	1.1%
Percentage from Small Programs	52.0%	38.0%	4.0%	4.0%	2.0%
Percentage from Large Programs	44.4%	46.7%	8.9%	0	0

Statement 13: The number of students completing our program, through certification and/or associate's degree strongly influences the sustainability of our CBTT program.

Summary of Participant Ratings for Number of Program Graduates

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Number of participants	35	41	14	4	1
Percentage of participants	36.8%	43.2%	14.7%	4.2%	1.1%
Percentage from Small Programs	28.0%	42.0%	20.0%	8.0%	2.0%
Percentage from Large Programs	46.7%	44.4%	8.9%	0	0

Appendix G Continued

Statement 14: Business and industry's hiring of CBTT program participants prior to completing the certificate or degree has not affected our CBTT program sustainability.

Summary of Participant Ratings for Hiring Practices of Non-Graduates

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Number of participants	10	44	21	17	3
Percentage of participants	10.5%	46.3%	22.1%	17.9%	3.2%
Percentage from Small Programs	8.0%	38.0%	32.0%	16.0%	6.0%
Percentage from Large Programs	13.3%	55.6%	11.1%	20.0%	0

Statement 15: Our CBTT program students have a high degree of job placement in the chemical industry.

Summary of Participant Ratings for Degree of Student Job Placement

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Number of participants	35	38	14	6	2
Percentage of participants	36.8%	40.0%	14.7%	6.3%	2.1%
Percentage from Small Programs	32.0%	40.0%	14.0%	10.0%	4.0%
Percentage from Large Programs	42.2%	40.0%	15.6%	2.2%	0

Appendix G Continued

Statement 16: Students in our program are able to seamlessly transfer most CBTT program course credits to regional four-year colleges and/or continuing education toward a Bachelor's degree.

Summary of Participant Ratings for Transferability of Program Credits

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Number of participants	20	32	17	17	9
Percentage of participants	21.1%	33.7%	17.9%	17.9%	9.5%
Percentage from Small Programs	26.0%	38.0%	14.0%	16.0%	6.0%
Percentage from Large Programs	15.6%	28.9%	22.2%	20.0%	13.3%

Statement 17: Obtaining and retaining full- and part-time faculty has never been an issue in our CBTT program.

Summary of Participant Ratings for Obtaining and Retaining Faculty

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Number of participants	19	35	12	22	7
Percentage of participants	20.0%	36.8%	12.6%	23.2%	7.4%
Percentage from Small Programs	22.0%	44.0%	12.0%	14.0%	8.0%
Percentage from Large Programs	17.8%	28.9%	13.3%	33.3%	6.7%

Appendix G Continued

Statement 18: The use of part-time faculty has never been an issue in the quality of instruction in our CBTT program.

Summary of Participant Ratings for Quality Instruction and Use of Part-time Faculty

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Number of participants	19	31	25	18	2
Percentage of participants	20.0%	32.6%	26.3%	18.9%	2.1%
Percentage from Small Programs	18.0%	34.0%	28.0%	16.0%	4.0%
Percentage from Large Programs	22.7%	31.8%	22.7	22.7%	0

Statement 19: Our college provides an abundance of professional development opportunities for our CBTT program faculty.

Summary of Participant Ratings for Faculty Professional Development Opportunties

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Number of participants	11	32	26	22	4
Percentage of participants	11.6%	33.7%	27.4%	23.2%	4.2%
Percentage from Small Programs	12.0%	28.0%	26.0%	26.0%	8.0%
Percentage from Large Programs	11.1%	40.0%	28.9%	20.0%	0

Appendix G Continued

Statement 20: Our CBTT program's sustainability is affected by excessive faculty workloads.

Summary of Participant Ratings for Excessive Faculty Workloads

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Number of participants	7	26	20	35	7
Percentage of participants	7.4%	27.4%	21.1%	36.8%	7.4%
Percentage from Small Programs	14.0%	30.0%	16.0%	32.0%	8.0%
Percentage from Large Programs	0	24.4%	26.7%	42.2%	6.7%

Statement 21: The funding provided by our college for equipment and instrumentation has been completely adequate for our CBTT program.

Summary of Participant Ratings for Equipment and Instrumentation Funding

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Number of participants	15	35	13	22	10
Percentage of participants	15.8%	36.8%	13.7%	23.2%	10.5%
Percentage from Small Programs	16.0%	34.0%	10.0%	26.0%	14.0%
Percentage from Large Programs	15.6%	40.0%	17.8%	20.0%	6.7%

Appendix G Continued

Statement 22: The funding provided by our college for laboratory facilities has strongly supported the needs of our CBTT program participants.

Summary of Participant Ratings for Classroom and Laboratory Funding

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Number of participants	20	32	14	25	4
Percentage of participants	21.1%	33.7%	14.7%	26.3%	4.2%
Percentage from Small Programs	18.0%	36.0%	14.0%	30.0%	2.0%
Percentage from Large Programs	24.4%	31.1%	15.6%	22.2%	6.7%

Statement 23: Funding and other resources, including instrumentation and equipment, provided by sources outside the college, have continued to support the sustainability of our CBTT program.

Summary of Participant Ratings for Funding from Outside Sources

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Number of participants	28	42	17	6	2
Percentage of participants	29.5%	44.2%	17.9%	6.3%	2.1%
Percentage from Small Programs	22.0%	38.0%	26.0%	10.0%	4.0%
Percentage from Large Programs	37.8%	51.1%	8.9%	2.2%	0

Appendix G Continued

Statement 24: The funding provided by our college for faculty positions in our CBTT program is completely adequate.

Summary of Participant Ratings for Faculty Position Funding

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Number of participants	8	31	25	27	4
Percentage of participants	8.4%	32.6%	26.3%	28.4%	4.2%
Percentage from Small Programs	12.0%	26.0%	18.0%	40.0%	4.0%
Percentage from Large Programs	4.4%	40.0%	35.6%	15.6%	4.4%

Statement 25: College administrators have strongly supported our CBTT program instructors through their encouragement in morale building and job satisfaction.

Summary of Participant Ratings for Administration Emotional Support

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Number of participants	13	30	32	16	4
Percentage of participants	13.7%	31.6%	33.7%	16.8%	4.2%
Percentage from Small Programs	8.0%	28.0%	30.0%	26.0%	8.0%
Percentage from Large Programs	20.0%	35.6%	37.8%	6.7%	0

Appendix G Continued

Statement 26: Our program has a "champion" from the college who has greatly contributed to the leadership and support of our CBTT program.

Summary of Participant Ratings for Presence of a Champion

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Number of participants	28	44	16	5	2
Percentage of participants	29.5%	46.3%	16.8%	5.3%	2.1%
Percentage from Small Programs	24.0%	42.0%	22.0%	10.0%	2.0%
Percentage from Large Programs	35.6%	51.1%	11.1%	0	2.2%

Statement 27: Flexible scheduling by our college has resulted in improved educational opportunities for our CBTT program students.

Summary of Participant Ratings for Flexible Scheduling of Classes

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Number of participants	16	39	28	10	2
Percentage of participants	16.8%	41.1%	29.5%	10.5%	2.1%
Percentage from Small Programs	6.0%	38.0%	38.0%	16.0%	2.0%
Percentage from Large Programs	28.9%	44.4%	20.0%	4.4%	2.2%

Appendix G Continued

Statement 28: Our CBTT program is highly visible to prospective students in our community.

Summary of Participant Ratings for Community Visibility of Program

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Number of participants	6	31	20	28	10
Percentage of participants	6.3%	32.6%	21.1%	29.5%	10.5%
Percentage from Small Programs	2.0%	18.0%	22.0%	42.0%	16.0%
Percentage from Large Programs	11.1%	48.9%	20.0%	15.6%	4.4%

Statement 29: Our community's perception of the chemistry-based technician profession is very positive.

Summary of Participant Ratings for Community Perception of the Profession

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Number of participants	7	34	40	13	1
Percentage of participants	7.4%	35.8%	42.1%	13.7%	1.1%
Percentage from Small Programs	0	24.0%	56.0%	18.0%	2.0%
Percentage from Large Programs	15.6%	48.9%	26.7%	8.9%	0

Appendix G Continued

Statement 30: Our college has an excellent marketing plan that has positively contributed to the enrollment of students in our CBTT program.

Summary of Participant Ratings for College Marketing Plan

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Number of participants	1	16	34	24	20
Percentage of participants	1.1%	16.8%	35.8%	25.3%	21.1%
Percentage from Small Programs	0	4.0%	36.0%	32.0%	28.0%
Percentage from Large Programs	2.2%	31.0%	35.6%	17.8%	13.3%

Statement 31: Our college actively promotes/markets our CBTT program to local secondary school students.

Summary of Participant Ratings for Program Promotion to Secondary Students

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Number of participants	8	29	19	25	14
Percentage of participants	8.4%	30.5%	20.0%	26.3%	14.7%
Percentage from Small Programs	2.0%	24.0%	22.0%	32.0%	20.0%
Percentage from Large Programs	15.6%	37.8%	17.8%	20.0%	8.9%

Appendix H: Correlational Analysis of Large and Small Programs

The Pearson coefficient (r) was used in the current study to determine if significant relationships existed between the independent and dependent variables. The correlations were used to determine the strength of associations between the sub-factors and program sustainability for large and small program participant data.

Small Programs

The Mann-Whitney U-statistic revealed some significant differences in the sub-factor ratings of small and large program participants. In order to gain further understanding, correlation coefficients were calculated to determine relationships between small program participant sub-factor ratings and their sustainability ratings.

Partnerships. The relationships between small program sustainability and each of the sub-factors of the clustered category of Partnership were analyzed through correlational statistics. A summary of the results of small program participants is presented in Table H1.

Appendix H Continued

Table H1: *Correlations of Partnerships Survey Questions 1-9 with Small Program Sustainability*

Independent Variable	Pearson Correlation	Significance
Degree of Partnering	0.52	0.00 **
Experiential Learning Opportunities	0.39	0.01 **
Employer Input in Curriculum Development	0.38	0.01 **
Responsiveness to Industry's Training Needs	0.25	0.09
Ethical Differences	-0.22	0.12
Administrative Style Differences	-0.18	0.21
President's Involvement in Partnerships	0.15	0.31
Education and Training Philosophy Differences	-0.15	0.29
Administration's Promotion of Partnerships	0.08	0.58

N = 50
** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

The results of the statistical analysis of small program participants showed that three of the sub-factors addressed in the survey had significant correlations with CBTT program sustainability. There is evidence that a high degree of partnerships, experiential learning opportunities, and extensive employer input in curriculum development are strongly related to sustainable programs.

Employer and student educational goals. The relationships between program sustainability and each of the sub-factors in the cluster category Employer and Student Educational Goals were analyzed through correlational statistics. A summary of the results is presented in Table H2.

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Table H2: *Correlations of Employer and Student Educational Goals Survey Questions 10-16 with Small Program Sustainability*

Independent Variable	Pearson Correlation	Significance
Job Skill Standards	0.48	0.00 **
Transferability of Program Credits	0.30	0.03 *
Degree of Student Job Placement	0.26	0.07
Number of Program Graduates	0.21	0.14
ACS Skill Standards	0.19	0.20
Employability Skills	0.18	0.22
Hiring of Non-graduates	-0.18	0.28

N = 50
** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

The results of the statistical analysis indicated a substantial relationship between CBTT program sustainability and the use of job skill standards from local industry, state labor boards or professional organizations. The analysis suggested that seamless transferability of program credits to a four-year institution also has a strong relationship to CBTT program sustainability.

Faculty and their resources. The relationships between program sustainability and each of the sub-factors of the clustered category Faculty and Their Resources were analyzed through correlational statistics. A summary of the results for small programs is presented in Table H3.

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Table H3: *Correlations of Faculty and Their Resources Survey Questions 17-27 with Small Program Sustainability*

Independent Variable	Pearson Correlation	Significance
Funding from Outside Sources	0.48	0.00 **
Presence of a Champion	0.34	0.02 *
Quality Instruction and Use of Part-time Faculty	-0.30	0.04 *
Excessive Faculty Workloads	0.27	0.06
Faculty Professional Development Opportunities	0.20	0.16
Obtaining and Retaining Faculty	-0.16	0.25
Administration Emotional Support	0.14	0.34
Flexible Scheduling of Classes	0.09	0.55
Classroom and Laboratory Funding	0.09	0.56
Faculty Position Funding	-0.01	0.95
Equipment and Instrumentation Funding	0.00	0.99

N = 50
** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

Two correlation coefficients for the sub-factors; funding from outside sources and the presence of a champion, indicated significant positive correlations with CBTT program sustainability. A significant inverse relationship between program sustainability and concerns over the use of part-time faculty suggested that instruction by part-timers has affected the quality of education as it relates to sustainability.

Community perceptions and marketing strategies. The relationships between each of the sub-factors of the clustered category Community Perceptions and Marketing Strategies and small program sustainability were analyzed through

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correlational statistics. A summary of the results of small program participant opinions is presented in Table H4.

Table H4: *Correlations of Community Perceptions and Marketing Survey Questions 28-31 with Small Program Sustainability*

Independent Variable	Pearson Correlation	Significance
Community Visibility of Program	0.07	0.64
Positive Perception of the Profession	0.07	0.62
College Marketing Plan	0.07	0.62
Program Promotion to Secondary Students	0.08	0.58

N = 50
** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

There is no evidence of significant associations between program sustainability and any of the sub-factors within the clustered category of Community Perceptions and Marketing Strategies. However, all of the sub-factors did indicate associations when all participant data was investigated, see Table 32.

Large Programs

In order to gain further understanding, correlation coefficients were calculated to determine relationships between large program's sub-factors and their program's sustainability.

Partnerships. The relationships between large program sustainability and each of the sub-factors associated with Partnerships were analyzed through correlational statistics. A summary of the results for large programs is presented in Table H5.

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Table H5: *Correlations of Partnership Survey Questions 1-9 with Large Program Sustainability*

Independent Variable	Pearson Correlation	Significance
Degree of Partnering	0.48	0.00 **
Administration's Promotion of Partnerships	0.42	0.00 **
Responsiveness to Industry's Training Needs	0.41	0.01 **
Employer Input in Curriculum Development	0.35	0.02 *
President's Involvement in Partnerships	0.24	0.11
Experiential Learning Opportunities	0.22	0.15
Education and Training Philosophy Differences	0.21	0.16
Ethical Differences	0.21	0.16
Administrative Style Differences	-0.01	0.95

N = 45
** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

The results of the statistical analysis of large program participants showed that four of the sub-factors associated with Partnerships had strong relationships with CBTT program sustainability. There is evidence that a high degree of partnerships, promotion of partnerships by the administration, responsiveness to industry's training needs, and employer input in curriculum development are strongly related to sustainable programs.

Employer and student educational goals. The relationships between large program sustainability and each of the sub-factors associated with Employer and Student Educational Goals were analyzed through correlational statistics. A summary of the results is presented in Table H6.

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Table H6: *Correlations of Employer and Student Educational Goals Survey Questions 10-16 with Large Program Sustainability*

Independent Variable	Pearson Correlation	Significance
Degree of Student Job Placement	0.54	0.00 **
Job Skill Standards	0.42	0.00 **
Hiring of Non-Graduates	0.42	0.01 **
Number of Student Completions of Program	0.22	0.15
Employability Skills	0.13	0.39
Transferability of Program Credits	-0.12	0.44
ACS Skill Standards	-0.10	0.51

N = 45
** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

The results of the statistical analysis show a high correlation between CBTT program sustainability and the degree of job placement. In addition, industry's practice of not hiring of students prior to program completion and the use of skill standards set by industry and local organizations have significant correlations.

Faculty and their resources. The relationships between large program sustainability and each of the sub-factors associated with Faculty and Their Resources were analyzed through correlational statistics. A summary of the results for large programs is presented in Table H7. There was only one sub-factor with a statistically significant correlation to large program sustainability; funding from outside sources.

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Table H7: *Correlations of Faculty and Their Resources Survey Questions 17-27 with Large Program Sustainability*

Independent Variable	Pearson Correlation	Significance
Funding from Outside Sources	0.31	0.04 *
Faculty Position Funding	-0.18	0.23
Administration Emotional Support	0.17	0.27
Faculty Professional Development Opportunities	0.11	0.47
Equipment and Instrumentation Funding	-0.11	0.48
Flexible Scheduling of Classes	0.10	0.51
Excessive Faculty Workloads	-0.09	0.56
Classroom and Laboratory Funding	-0.05	0.73
Quality Instruction and Use of Part-time Faculty	-0.04	0.82
Presence of a Champion	0.00	0.98
Obtaining and Retaining Faculty	0.00	0.99

N = 45
** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

Community perceptions and marketing strategies. The relationships between large programs sustainability and each the sub-factors associated with Community Perceptions and Marketing Strategies and large program sustainability were analyzed through correlational statistics. A summary of the results is presented in Table H8. The presence of an effective marketing plan and community visibility were significantly correlated with program sustainability.

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Table H8: *Correlations of Community Perceptions and Marketing Survey Questions 28-31 with Large Program Sustainability*

Independent Variable	Pearson Correlation	Significance
Community Visibility of Program	0.40	0.01**
College Marketing Plan	0.29	0.05*
Positive Perception of the Profession	0.25	0.10
Program Promotion to Secondary Students	0.23	0.14

N = 45
** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

Summary. Although the sample sizes were compromised by splitting participants into small and large program groups, there were several significant correlations of the sub-factors to large and small program sustainability. Organized by program size, Table H9 indicates the sub-factors significantly correlated to sustainability.

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Table H9: *Summary of Significantly Correlated Sub-Factors to Sustainability in Small and Large Programs*

Small Programs	Large Programs
Partnerships with business and industry	Partnerships with business and industry
Experiential learning opportunities	College responsiveness
Employer input in curriculum	Employer input in curriculum
Use of job skill standards	Use of job skill standards
Transferability of program credits	Administration's promotion of partnerships
Quality Instruction and Use of Part-time Faculty	Hiring of non-graduates
Funding and other resources from outside the college	Funding and other resources from outside the college
The presence of a champion	High visibility of the program to the community
	Degree of student job placement
	A college marketing plan

Large and small programs have similar correlations between some of the sub-factors and program sustainability, including a high degree of partnering with business and industry, employer input in curriculum to program sustainability, use of job skill standards, and funding and other resources from outside the college. However, several

Appendix H Continued

important differences between small and large programs were evident. Small program participant data indicated strong associations between sustainability and experiential learning opportunities, transferability of program credits, the presence of a champion, and the consequences of the use of part-time faculty and excessive faculty workloads. On the other hand, large program participant data reflected relationships between sustainability and college responsiveness, administration's promotion of partnerships, business and industry refraining from hiring non-graduates, high visibility of the program, student job placement, and the presence of a college marketing plan. These differences support this researcher's decision to separately analyze the data from small and large CBTT programs. Further statistical analysis of these differences in opinions was discussed in research question two.

Appendix I: Multiple Regression Analysis of Large and Small Program Participant Ratings

To determine the combined relationship of the factors associated with CBTT program sustainability this researcher performed multiple regression analysis on the survey ratings of the sub-factors of small program participants. The model provided by the multiple regression analysis offered additional information with regard to an explanation of small program sustainability. A summary of the results of the stepwise multiple regression analysis is provided in the following table.

Table I1: Summary of Multiple Regression Analysis of Small Program Sustainability

Independent Variable	R	R^2	Beta	Sig
(Constant)			1.321	0.040
Degree of Partnering	0.523	0.259	0.363	0.001**
Use of Part-time Faculty and Quality Instruction	0.591	0.321	-0.320	0.002**
Transferability of Program Credits	0.666	0.407	0.256	0.007**
Experiential Learning Opportunities	0.707	0.456	0.247	0.028*

Dependent Variable: Sustainability

** Significant at the 0.01 level
* Significant at the 0.05 level

N = 50

The R^2 value for the model presented was determined to be 0.456 with an overall p-value of 0.028. According to the model, about 47 % of the variation in small CBTT program sustainability rating can be explained by knowing the degree of partnering, the extent of the use of part-time faculty as it affects instructional quality, program credit transferability, and experiential learning opportunities.

Appendix I Continued

To determine the combined relationship of the factors associated with CBTT program sustainability, this researcher also performed multiple regression analysis on the survey ratings of the sub-factors of large program participants. The model provided by the multiple regression analysis offered additional information with regard to an explanation of large program sustainability. A summary of the results of the stepwise multiple regression analysis is provided in the following table.

Table I2: *Summary of Multiple Regression Analysis of Large Program Sustainability*

Independent Variable	R	R^2	Beta	Sig
(Constant)			2.143	0.000**
Degree of Student Job Placement	0.539	0.274	0.365	0.000**
Hiring of Non-graduates	0.591	0.397	0.225	0.004**

Dependent Variable: Sustainability

** Significant at the 0.01 level
* Significant at the 0.05 level

N = 45

The R^2 value for the model presented was determined to be 0.397 with an overall p-value of 0.028. According to the model, about 40% of the variation in large CBTT program sustainability ratings can be explained by knowing the degree of student job placement and the extent of the hiring practices of non-graduates by business and industry.

Appendix J: Factor Analysis

To gain further insight into the factors and their relationships with CBTT program sustainability, the survey item responses were examined using factor analysis. Factor analysis allowed this researcher to identify possible underlying forcing factors and disentangle certain complex interrelationships of the current study's sub-factors associated with program sustainability. More specifically, this researcher attempted to determine any patterns of relationships among the data and define distinct groups of interrelated data. These distinct groups concentrated the information obtained from the survey participants and grouped the 31 Likert scale sub-factors into descriptive categories. The current study used an *oblique rotation* to determine the best clustered patterns for the sub-factors relating to program sustainability.

> Besides yielding more information, oblique rotation is justified on epistemological grounds. One justification is that [the] real world should not be treated as though phenomena coagulate in unrelated clusters. As phenomena can be interrelated in clusters, so the clusters themselves can be related. Oblique rotation allows this reality to be reflected in the loadings of the factors and their correlations. (Rummel, n.d.)

Fields (2005) suggested reviewing the one-tailed significance values in the correlation matrix of all variables to check the pattern of relationships. Furthermore, Fields recommended considering the exclusion of sub-factors which had the majority of significance values greater than 0.05 because this indicates that the variables do not correlate well with the other variables. The current study inspected the correlation matrix for any sub-factors with a majority of significance values greater than 0.05 when correlated with other sub-factors. The excluded sub-factors were college

Appendix J Continued

responsiveness, differences in education and training philosophies and ethics, the number of program graduates, student job placement, transferability, obtaining and retaining faculty, use of part-time faculty, faculty workloads, and faculty position funding. These sub-factors were excluded from the final factor analysis. After excluding these sub-factors, the determinant was found to be 2.65×10^{-5}, which is greater than the necessary value of 0.00001 (Fields, 2005). A six-component solution was identified, and a scree plot of eigenvalues indicated that the factor analysis was acceptable. Cronbach's alpha values for Components 1 through 6 were 0.857, 0.790, 0.770, 0.670, 0.792, and 0.517 respectively. Each of the six identified components included related sub-factors that were given an appropriate category title. A summary of the factor analysis is shown in the table below.

Summary of Factor Analysis

Component	Percent of Variance	Cumulative Percent
Community Perceptions and Marketing	27.598	27.598
External Engagement by Business and Industry	11.373	38.972
Program Operations and Administration	10.553	49.525
Foundations for Program Support	8.134	57.659
Institutionally Funded Support	6.443	64.102
Employer Student Support	4.869	68.971

N = 95
Significance: 0.000
Determinant: 2.65×10^{-5}
Kaiser-Meyer-Olkin Measure: 0.773

Component 1, "Community Perceptions and Marketing" consisted of four sub-factors with the following coefficients: 0.871 (Community Visibility of Program),

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0.850 (Positive Perception of the Profession), 0.825 (College Marketing Plan), and 0.692 (Program Promotion to Secondary Students). Component 1 had an eigenvalue of 5.796 and accounted for 27.6% of the variance.

Component 2, "External Engagement by Business and Industry" consisted of four sub-factors with the following coefficients: 0.765 (Degree of Partnering), 0.999 (Employer Input in Curriculum Development), 0.536 (Job Skill Standards), 0.608 (Funding from Outside Sources). Component 2 had an eigenvalue of 2.388 and accounted for 11.4% of the variance.

Component 3, "Program Operations and Administration" consisted of three sub-factors with the following coefficients: 0.811 (Administration's Promotion of Partnerships), 0.768 (President's Involvement in Partnerships), and 0.684 (Administrative Style Differences). Component 3 had an eigenvalue of 2.216 and accounted for 10.6% of the variance.

Component 4, "Foundations for Program Support" consisted of five sub-factors with the following coefficients: 0.520 (ACS Skill Standards), 0.692 (Employability Skills), 0.488 (Administration Emotional Support), 0.956 (Presence of a Champion), 0.564 (Flexible Scheduling of Classes). Component 4 had an eigenvalue of 1.708 and accounted for 8.1% of the variance.

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Component 5, "Institutionally Funded Support" consisted of three sub-factors with the following coefficients: 0.555 (Faculty Professional Development), 0.926 (Equipment and Instrumentation Funding), and 0.937 (Classroom and Laboratory Funding). Component 5 had an eigenvalue of 1.353 and accounted for 6.4% of the variance.

Component 6, "Employer Practices for Student Educational Success" consisted of two sub-factors with the following coefficients: 0.713 (Student Experiential Learning Opportunities), and 0.877 (Hiring of Non-graduates). Component 6 had an eigenvalue of 1.022 and accounted for 4.9% of the variance.

In summary, the results of the factor analysis suggested that approximately 69% of the variance in sustainability of CBTT programs may be explained by six separate components (Community Perceptions and Marketing, External Engagement by Business and Industry, Program Operations and Administration, Foundations for Program Support, Institutionally Funded Support, and Employer Practices for Student Educational Success). These components consist of related sub-factors that, together, contribute to the formation of composite variables. This information may be useful in the design of future studies as potential forcing factors as opposed to predictive factors. It is noteworthy that the six factor analysis components bear a resemblance to the current study's clustered categories.

Appendix K: Multiple Regression Analysis of Sub-Factors Used in Factor Analysis

In attempting to determine the combined relationship of the factors associated with CBTT program sustainability, this researcher performed multiple regression analysis on the survey ratings of the sub-factors used in the factor analysis, see Appendix I. The model provided by the multiple regression analysis proved to be the same model discussed earlier. A summary of the results of the stepwise multiple regression analysis is provided in the following table.

Summary of Multiple Regression Analysis of the Most Strongly Correlated Sub-Factors Associated with Program Sustainability

Independent Variable	R	R^2	Beta	Significance
(Constant)			1.383	0.01
Degree of Partnering	0.574	0.330	0.381	0.00**
Funding from Outside Sources	0.640	0.410	0.286	0.00**
Community Visibility of Program	0.668	0.446	0.172	0.02*
Administrative Style Differences	-0.166	0.470	-0.210	0.00**

Dependent Variable: Sustainability

** Significant at the 0.01 level
 * Significant at the 0.05 level

N = 95

The R^2 value for the model presented was determined to be 0.470 with an overall p-value of 0.000. According to the model, about 47% of the variation in a CBTT program sustainability rating can be explained by knowing the degree of partnering, level of support and funding from outside sources, visibility of the program

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to the local community, and the extent of differences in the administrative styles between the college and business and industry.

Appendix L

Clustered Category Rankings and Ratings of Faculty and Administrators from Related Programs

Respondents ranked the importance of each of the clustered categories from 1 to 4, with 4 being the highest. To determine the relative importance of the rankings of the clustered categories to sustainability, programs that had at least one faculty and one administrator were analyzed to determine if the use of all participants was valid in interpreting the differences in faculty and administrator perspectives.

The data collected from CBTT program administrators gave the following ordered ranking of importance to sustainability: Partnerships, Employer and Student Educational Goals, Faculty and Their Resources and Community Perceptions and Marketing Strategies, see table below. Faculty ranked the clustered categories with respect to the importance to sustainability as being Partnerships, Faculty and Their Resources, Employer and Student Goals, and Community Perceptions and Marketing Strategies. Both faculty and administrators ranked partnerships as the most important category and community perceptions and marketing strategies as the least important category of sub-factors associated with program sustainability. In addition, analysis of the mean rankings of the clustered categories indicated that faculty, as contrasted with administrators, Faculty and Their Resources felt were more important than Employer and Student Educational Goals.

Table L1: *Summary of Mean Rankings of Clustered Categories of Faculty and Administrators from Related Programs*

Clustered Category	Administrators Mean	Administrators SD	Faculty Mean	Faculty SD
Partnerships	2.80	1.32	2.76	1.15
Faculty and Their Resources	2.40	1.06	2.59	1.15
Employer and Student Educational Goals	2.60	0.91	2.48	0.91
Community Perceptions and Marketing Strategy	2.20	1.21	2.14	1.22

		Administrators	Faculty
N	Valid	15	29

The differences in rankings of the four clustered categories by program faculty and administrators were statistically analyzed using the Mann-Whitney test. The results are presented in the table below. At the 0.05 level of confidence there were no statistically significant differences in the rankings by program faculty and administrators regarding the importance of the four clustered categories.

Table L2: *Mann-Whitney Test of Significant Differences in Rankings of Administrators and Faculty of the Clustered Categories from Related Programs*

Clustered Category	Z-Value	Sig.
Partnerships	-0.44	0.66
Employer and Student Educational Goals	-0.56	0.58
Faculty and Their Resources	-0.17	0.87
Community Perceptions and Marketing Strategy	-0.08	0.94

** Significant at the 0.01 level
* Significant at the 0.05 level

N	Valid	29 Faculty Participants
		15 Administrator Participants

Clustered Category Sub-Factor Ratings of Faculty and Administrators

This researcher used the Mann-Whitney test of significance to determine whether or not there were statistically different ratings by faculty and administrator program participants concerning the sub-factors relating to program sustainability. The Mann-Whitney test of significance was deemed appropriate in order to compare the ratings of the two unequal sample sized groups having non-parametric rating distributions. This test was used to compare differences in the distributions associated with the 31 Likert scale statements in the survey. The null hypothesis (H_o) was that there were no significant differences in ratings between administrator and faculty participants of the sub-factors relating to program sustainability. The alternative hypothesis (H_1) was that significant differences were indicated. A summary of the results for each of the sub-factor ratings is presented in the table below.

Table L3: *Mann-Whitney Tests for Significant Differences in Ratings of Administrators and Faculty from Related Programs of Sustainability and the Sub-Factors*

Variables	Faculty Mean	Faculty SD	Administrators Mean	Administrators SD	Z-Value	Sig.
Sustainability	4.13	0.75	4.13	0.92	-0.24	0.81
Degree of Partnering	4.25	0.76	4.20	1.01	-0.21	0.83
Responsiveness to Industry's Training Needs	4.59	0.50	4.47	0.64	-0.55	0.58
Administration's Promotion of Partnerships	3.88	1.10	4.00	1.00	-0.25	0.80
President's Involvement in Partnerships	3.72	1.05	4.13	0.74	-1.25	0.21
Education and Training Philosophy Differences	3.81	0.74	3.60	0.74	-0.89	0.38
Administrative Style Differences	3.69	1.00	3.80	0.56	-0.18	0.85
Ethical Differences	3.84	0.88	3.87	0.52	-0.00	1.00
Experiential Learning Opportunities	4.13	0.98	3.93	1.22	-0.32	0.75
Employer Input in Curriculum Development	4.28	0.68	4.40	0.91	-0.94	0.35
Job Skill Standards	4.09	0.93	4.00	1.07	-0.17	0.86
ACS Skill Standards	3.28	1.40	3.00	1.25	-0.74	0.46
Employability Skills	4.56	0.67	4.27	0.88	-1.20	0.23
Number of Program Graduates	4.00	1.02	4.27	0.80	-0.82	0.41
Hiring Practices of Non-graduates	3.50	1.08	3.47	0.99	-0.05	0.96
Degree of Student Job Placement	4.16	0.99	4.27	0.88	-0.31	0.76
Transferability of Program Credits	3.91	1.06	3.80	1.26	-0.09	0.93
Obtaining and Retaining Faculty	3.44	1.16	3.40	1.24	-0.01	0.99
Quality of Instruction and Use of Part-time Faculty	3.42	0.99	3.27	1.03	-0.49	0.63
Faculty Professional Development Opportunities	3.34	1.00	3.27	1.03	-0.24	0.81
Excessive Faculty Workloads	3.25	0.98	2.27	0.70	-3.15	0.00**
Equipment and Instrumentation Funding	3.31	1.33	3.40	1.24	-0.17	0.87
Classroom and Laboratory Funding	3.47	1.19	3.67	1.23	-0.61	0.55
Funding from Outside Sources	4.13	0.75	4.13	0.83	-0.20	0.84
Faculty Position Funding	3.16	1.05	3.53	0.92	-1.28	0.20
Administration Emotional Support	3.19	1.06	3.60	1.06	-1.12	0.26
Presence of a Champion	4.00	0.84	4.13	0.92	-0.62	0.54
Flexible Scheduling of Classes	3.53	0.88	3.60	1.12	-0.18	0.86
Community Visibility of Program	2.88	1.07	3.07	1.33	-0.52	0.60
Positive Perception of the Profession	3.38	0.87	3.53	0.92	-0.50	0.62
College Marketing Plan	2.56	0.95	2.47	0.99	-0.34	0.73
Program Promotion to Secondary Students	2.97	1.12	3.73	1.33	-0.74	0.46

** Significant at the 0.01 level (2-tailed)
* Significant at the 0.05 level (2-tailed)

N = 44 (15 Administrators and 29 Faculty)

There was no significant difference in the ratings of program sustainability by administrator and faculty participants. Only one of the 31 clustered category sub-factors displayed significantly different ratings across the entire set of survey items: the effect of excessive faculty workloads as it relates to their program's sustainability. More faculty participants felt that excessive faculty workloads had affected their program's sustainability than did administrator participants.