SCIENCE AND TECHNOLOGY SKILLED WORKFORCE AND RELATED EDUCATIONAL ISSUES

A REPORT PREPARED FOR

THE CALIFORNIA COUNCIL ON SCIENCE AND TECHNOLOGY

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ABOUT THE CCST CALIFORNIA REPORT ON THE ENVIRONMENT FOR SCIENCE AND TECHNOLOGY

CCST's California Report on the Environment for Science and Technology (CREST) has analyzed the state's science and technology infrastructure to determine if California has the people, capital investment and necessary state governmental policies to maintain California's leadership in the face of increasing worldwide competition. Through eight individual research projects, CREST analyzes the state's ability to create and use new technology. By facilitating a dialog with policy makers, industry leaders, and academic communities, CCST hopes to enhance economic growth and quality of life for Californians.

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The California Council on Science and Technology is a nonprofit organization established in 1988 at the request of the California State Government and sponsored by the major post secondary institutions of California, in conjunction with leading private-sector firms. CCST's mission is to improve science and technology policy and application in California by proposing programs, conducting analyses, and helping government implement policies and initiatives for a better economy and quality of life.

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1. Introduction

Any analysis of the infrastructure required to support the future of science and technology in California must be grounded in both the perceived skill needs of existing business and industry as well as the actual state of the educational system that provides these skills. Although perceptions may not always represent reality, they may provide essential starting points. A careful analysis of these perceptions holds the potential to gain an understanding of the underlying structures that approximate reality. Once these underlying structures reveal themselves, serious attention can be given to the system that maintains and perpetuates it. The timeliness of this study is supported by the focus of Governor Gray Davis' current budget focus on Education and a Trained Workforce (1999), as well as the Bureau of Labor Statistics (BLS) linking of education levels to decreased unemployment (June 1998).

The purpose of this project is twofold. The first (Phase I: Workforce Needs) is to conduct a small number of case studies of selected growth industries to investigate perceptions of workforce needs at various organizational levels. By examining perceptions across "vertical slices" of each case, the project aims to develop a coherent portrait of needs that reveals common themes along with variations. The California Department of Employment Development (EDD) in their statewide survey (March 1998) of Info-Tech businesses, identified the need for skills and for skills training. The second (Phase II: Public School Infrastructure) extends the first by investigating what is known in the field of K-16 education, and about the extent and quality of opportunities for students to move through the various pipelines that generate needed talent. Reports from Public Agenda Online (April 1999) displayed findings from the Organization for Economic Cooperation and Development (OECD) showing that in 1996 the U.S. was falling behind in high school graduations, and another report from the OECD reporting that almost half of the math and reading levels of adults in the U.S. are too low for life- and work- competencies.

1.1 Workforce Needs

The theoretical and practical components of the aspect of the study are grounded in the academic/career research of Stanford's Dr. John Krumboltz (1986). The John Immerwahr (January, 1999) Public Agenda Report to the National Center for Public Policy and Higher Education provides consensus to the findings of this study (namely, identifying the need for stronger higher education, identifying colleges as a crucial source for scientific and technological innovation, identifying not only the need for students to obtain better writing and communication skills, but also the need for students to become creative and independent thinkers). The research of Los Angeles County and Orange County in their Business Resource, Assistance, and Innovation Network (BRAIN) Plan (1998), also has identified similar findings.

In 1991, the U.S. Department of Labor released a report titled, *What Work Requires of Schools: A SCANS Report for America 2000*. The Secretary's Commission on Achieving Necessary Skills (SCANS) was asked to examine the demands of the workplace and whether young people are capable of meeting those demands. Specifically, the Commission was directed to advise the Secretary on the level of skills required to enter employment. In doing so, two tasks were accomplished: (1) Defining the skills needed, and (2) Proposing acceptable levels of proficiency for them. Their conclusions regarding needed skills mirrored previous studies' findings as well as the current one completed for the *Workforce Needs* aspect of this study. In short, they found three general categories of needs for successful careers in science and technology as well as other fields: (1) *Basic Skills* like writing and mathematics; (2) *Thinking Skills* like reasoning, critical thinking, and problem solving, and; (3) *Personal Qualities* like responsibility, self-esteem, and integrity (SCANS Report 1991).

A review of local and national headlines reveals that high-tech jobs are indeed essential to local as well as statewide economies. Yet there seems to be a definite lack of a prepared workforce to fill the needed positions -- especially in the science and technology industry. Across the state there is a slow but growing recognition among high schools and universities that preparing a potential workforce -- in terms basic skills -- prior to the needs for remediation, is beneficial to both industry functioning and a healthy economy. The benefits extend not only to industry but also ultimately to communities, schools, and individuals. Locally, the San Bernardino Sun News (April 1999) reported that employers have to teach basic skills prior to training job skills.

Addressing economic and workforce needs are necessary and timely, especially for California. These are times of growth and potential for the state. By all indications, California is a technological leader, innovator and generator of new industries. However, California will be entering the new century with a serious lack of trained workforce and a severe skill gap between what science and technology industries need, and what they receive. Thus, now is the time for examining the strengths of and challenges to preparing a trained, competent and available workforce. In a report from the American Electronics Association (March 1999), the following points were highlighted: 1) there is a shortage of an educated workforce—especially in California, 2) there is a need for educated, tech-savvy, forward thinking workers, 3) highly educated workers are the electronic high-tech industry's most valuable resource, 4) supply of qualified graduates is down, 5) training is not just needed K-12, but is needed K-Ph.D., 5) Industry is committed to high-level support of education, and 6) that Industry, Government, and Education need to be working together.

This particular pilot study of the *Workforce Needs* aspect of this study is a component of a much larger study being conducted by the California Council on Science and Technology (CCST). The overall framework is to critically re-evaluate the structure and enablement of research and development in science and technology in California, especially in terms of identifying, coordinating and producing guidelines and detailed approaches that would tangibly improve the operation of the infrastructure for science and technology. The message the CCST is carrying to state legislators is that it is timely that California embarks on a process of strategic planning specifically in science and technology to ensure that the infrastructure for economic success in realized.

The focus of *Phase I: Workforce Needs* is on the "human capital" aspect, that is, what kind of workforce is needed for science and technology firms to make them more competitive in the current global market. This question is addressed in terms of what skills are needed of high school and college graduates, by industry, in order for them to be considered a "competent" workforce. The first part of this study (Phase I: Workforce Needs) identifies which skills are most needed, and which skills are actually being received by science and technology industries. The second part of this study (Phase II: Public School Infrastructure) focuses on the educational aspect, namely what is the current quality of the educational system regarding math and science, in terms of both the teachers and the students emerging from the system.

The conceptual framework of the *Workforce Needs* aspect of this study investigates a fundamental distinction that has emerged in previous studies (Krumboltz, 1986) -- the contrast between academic and personal competence. At one end of this continuum is an emphasis on basic skills: reading, writing, and arithmetic. The idea may be extended to reasoning and communication competence, but the fundamental notion is the same -- schools should do a solid job of teaching students the essential subject matters. At the other end of the continuum are capabilities better represented by words like *responsibility*, *dependability*, *motivation*, and *commitment*.

Very little research has been done on these matters. However, several years ago Stanford's John Krumboltz (1986) surveyed high school students along with their teachers to help determine educational priorities. He asked two questions: (1) What were the most critical outcomes of a high school education, and (2) What were high school courses most responsible for teaching? The list of ten items included five academic areas (language arts, math, science, etc.) and five "personal" areas (promptness, responsibility, etc.). The results were dramatically consistent across the board: All of the groups said that the most critical outcomes of schooling were the personal areas (see Figure 1). Yet, it was also found that high school courses should emphasize the academics (see Figure 2). This tension is very likely at the root of current dissatisfaction with high school graduates; one of the background tasks for this project is to review previous surveys, which show that the personal areas -- as identified by Krumboltz -- are at the top of industry lists. This study's initial survey design was modeled on the Krumboltz research and revised to accommodate more recent data and the specifics of the target industry.

Historically, little research has been done by the academic community to link industry needs with California universities and colleges. On the other hand, industry itself has produced a number of studies identifying what skills are necessary for a competent and competitive workforce. The Council on Competitiveness (February 1999), in light of "emerging U.S. vulnerabilities" and "weakness in the talent pool" have focused their recommendations toward people needing to become: literate, learn to apply information, and to be innovative. Expenditures in academic research have actually shown a decline over the past two decades (from 13.6% of the countries total research expenditures in 1975 to 11.7% in 1995) (CCST, July 1998). This project's surveying of business and industry is groundbreaking because of the very fact that it extends the data on the needs of industry with respect to workforce development, training and education.

To ensure the supply of a skilled workforce capable of meeting the needs of industry will be the major challenge for California. Thus, *Phase I: Workforce Needs* seeks to extend what we know in two ways. First the surveys have been designed to tap into perceived needs at different levels within the target industries. Second the surveys have been combined with interviews of selected participants to obtain a fuller representation of the issues. Implications for workforce preparedness are addressed relative to the educational system *Phase I: Workforce Needs*, and in more depth *in Phase II: Public School Infrastructure*. The scope of this study is one similar to the lens through which the National Science Foundation (NSF) in their "Transitions from Childhood to Workforce" Program views education (December 1998).

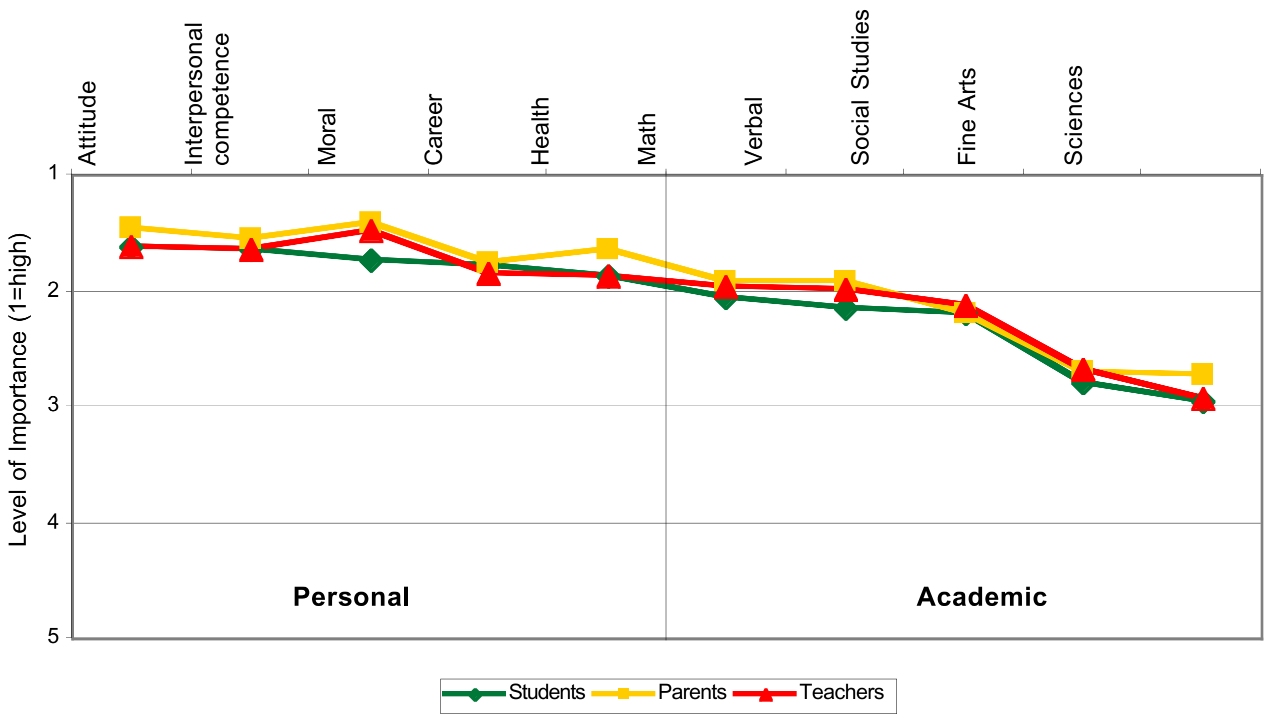

Figure 1. Importance
John Krumhboltz, Stanford University, 1986

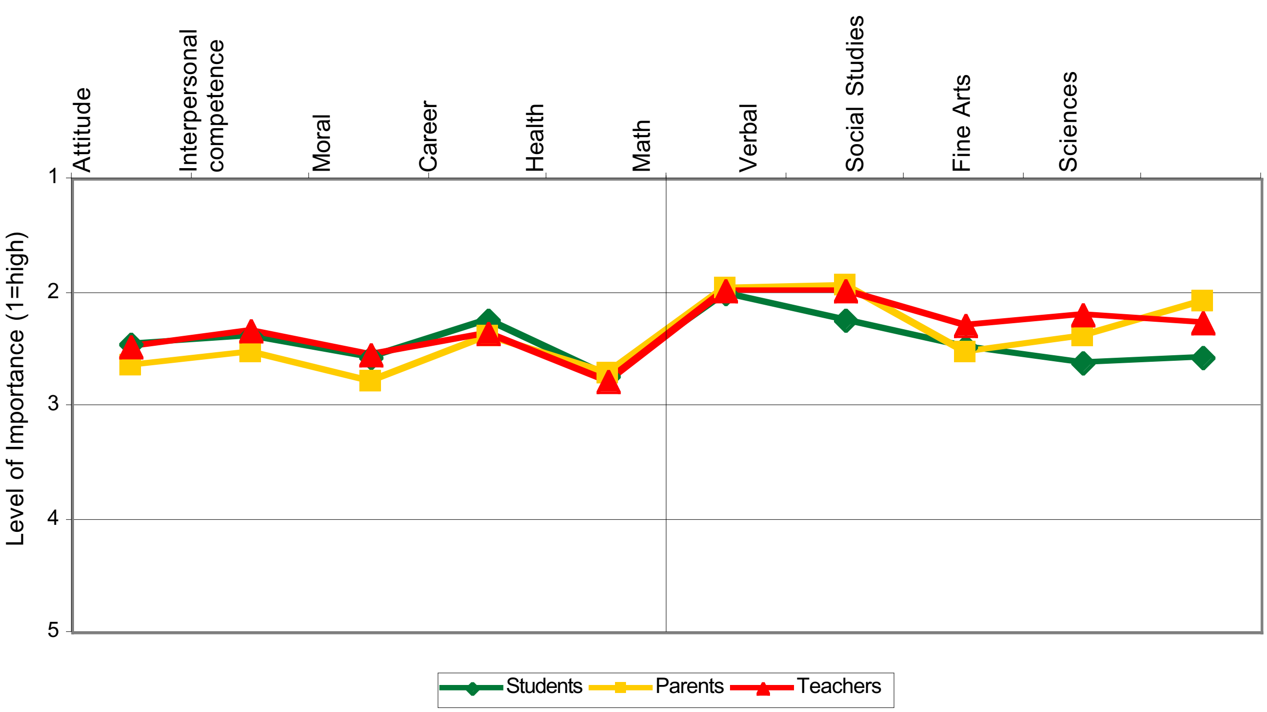

Figure 2. School Responsibility
John Krumhboltz, Stanford University, 1986

1.2 Public School Infrastructure

In June 1999, the U.S. Department of Commerce Technology Administration (USDCTA) released a report titled, *The Digital Workforce: Building Infotech Skills at the Speed of Innovation*. In it, they explain that the "digital work force challenge" has been the subject of much debate among representatives of industry (who believe there is a "shortage" of information technology (IT) workers), employee groups (who believe adequate numbers of highly trained technical professionals are available) and economists (who argue that market forces will take care of any problem). Although each of these perspectives has merit, the USDCTA claimed that the true nature of the challenge is more complex than any of these views individually. The challenge is driven by the unique nature of information technology and its pervasive role throughout the U.S. economy and our society. This report discusses the impact of rapid creation and adoption of IT on the U.S. economy, describes the demand and supply trends for core IT occupations, discusses the business environment and its impact on the IT labor market, and proposes steps key stakeholders can take to address the challenge.

This issue is so important that Education Secretary Richard W. Riley has established the *National Commission on Mathematics and Science Teaching* for the 21st Century, which will recommend ways to improve the recruitment, preparation, retention, and support of math and science teachers. John Glenn will chair the 31-member commission. Governors Geringer of Wyoming and Hunt of North Carolina also will serve on the commission. Other members will include representatives of business, industry, academia, non-profit organizations, and government. The U.S. is expected to need an additional 2.2 million teachers over the next decade due to a record number of retirements and the increase in the number of school-aged children. Math and science teachers are anticipated to be in particularly short supply. The Commission will report its recommendations to Secretary Riley by the Fall of 2000.

It should also be noted that the National Science Board has released a report on mathematics and science achievement called, *Preparing Our Children: Math and Science Education in the National Interest*, in February of this year. It deals with skills that are separately need by students as well as ways in which teachers can be prepared to teach these skills. A report from a National Science Foundation Workshop written in 1998, titled, *Investing in Tomorrow's Teachers*: *The Integral Role of Two-Year Colleges in the Science and Mathematics Preparation of Prospective Teachers*, also deals with the need of teacher preparation for educating future workers in science and technology fields. In an Issue Brief from the Council of Chief State School Officers (CCSSO) (Spring, 1998), the benefits of collaboration and teacher education were focused around workforce development, family policy and programs, partnerships, and student outcomes.

Building on the above examples of the obvious need for better qualified teachers, the first stage of the *Public School Infrastructure* aspect of the study was to assemble in compact form several sources of existing data. For instance, the California Department of Education (CDE) has compiled information about course-taking patterns during the middle and high school years in recent years as part of the California Basic Educational Data System (CBEDS). Based on these findings, interview protocols were designed for approaching several local districts and high schools, to obtain more in-depth and validated perspectives on how the system is operating.

CERC (the California Educational Research Collaborative located in the School of Education) has constructed a ten-year database of CBEDS records that have been "cleaned" and prepared into a database. Thus, an exploratory analysis of teacher credential and course-taking trends for the entire State was made. Data on SAT9 test scores was then merged with these data allowing for a school-level analysis of relations between teacher/course resources and standardized student achievement. These analyses offer some fascinating insights into trends.

The second stage of *Phase II: Public School Infrastructure* was to bring together UCR, local area districts, high schools, faculty, administrators, and businesspersons in a 'think-tank' type settings. The objective is to begin to identify from an "math/science" perspective some of the key dimensions which when taken into high school settings, will help students better understand how their education applies to the career-world. The focus of these meetings was to identify which of the dimensions (teacher development, curriculum realignment, and/or education policy) are best targeted for change. There was both a spotlight on how to increase the connections between school, college, and career and, and once these connections are created, students' understanding of academics relative to careers are expected to become more relevant. Secondly, identify how teachers could be better equipped for motivating and engaging students by relating the relevance of academic training to students' potential careers.

Thus, by connecting science and mathematics education across distinct educational levels, this project ultimately aims to strengthen student academic achievement, thereby expanding the number of students qualified for high skill leveled careers. This project will provide a unique opportunity for university, school, and business collaboration, focused on identifying how to help students see where they "will be in ten years," and "how to get there."

2. Workforce Needs

2.1 Overview

This next section discusses the Workforce Needs aspect of this study. The goal of this feature of the study was to look at the perceptions of business and industry leaders as to what they need from a qualified workforce. They were asked to fill out hard copy and online-surveys in order to gauge what they believed was most needed in three basic skill areas: Academic Skills, Career Skills, ands Personal Skills.

Due to the nature of the subject being studied as well as the make-up of the sample a grave difficulty was experienced in data collection. Only a small number of firms were selected for this initial pilot study. The quantity of responses was less than expected, possibly due to a number of reasons, including the groundbreaking nature of this data gathering and creating endeavor. Other reasons for the lower response rate centers on the particular pool that the data was generated from. Because of the nature and size of many science and technology industries, a long-term commitment must be made in terms of obtaining appropriate respondents with the time to complete them. An extensive follow up procedure must also be undertaken to receive responses. Nonetheless the data generated in this study is consistent with previous studies and reports on this subject. This data has also yielded important insights into the perceived needs of business and industry.

Findings demonstrated that business and industry is consistently looking for higher performance from its workforce on all skill indicators:

- A stronger secondary and higher education system
- Students are poorly prepared in science and technology
- Student motivation and responsibility is essential
- Commitment to work, a work ethic, and a general preparedness for the work-world are vital
- Critical thinking and research skills are necessary
- Technical writing and computer skills are important
- Creativity, self-directedness, and teamwork are important
- Foreign language and social skills are unnecessary
- Personal skills from home and parents are important
- In-House training to supplement skills and preparation are needed
- Role of community colleges and vocational schools is downplayed

2.2 Areas of Consensus

The following section relates the findings of the current survey of business and industry to similar findings of other studies and reports. These "areas of consensus" are presented to help strengthen the argument that perceptions about workforce preparedness (as well as which specific skills and abilities are identified as being needed) are consistent among other studies that have focused on this subject matter.

2.2.1 Regarding the Education System

The majority of respondents believed that a stronger secondary and higher education system is needed to prepare a potential science and technology workforce.

Perhaps the most important finding is a perception of a general lack of preparedness of students graduating from secondary and higher education institutions in respect to science and technology positions. This issue emerged based on informal interviews conducted on some of the respondents. It was believed that one of the first issues that needed to be addressed was a strengthening of the secondary and higher education systems in California.

This finding is supported by a number of different sources including John Immerwahr's (1999) Public Agenda Report titled, *Taking Responsibility: Leaders Expectations of Higher Education*. Immerwahr's findings (see Figure 3) revealed that over 97% of education and business leaders believed that a stronger higher education system was indeed important to help foster economic growth and "the well-being of American society." Nation's colleges were also identified as the key source for technological and scientific innovation.

Local economic development councils (BRAIN Plan and CALWorks Project 1998) in the Los Angeles County region and the South Bay have also identified the importance of secondary and higher education institutions in providing essential skills and training. For them the strengthening of these institutions are seen as key for providing potential workers in science and technology fields and for helping to revitalize local economies.

Another interesting set of findings that emerged is related to what is perceived as a lack of preparedness, commitment, responsibility, or general work ethic**.**

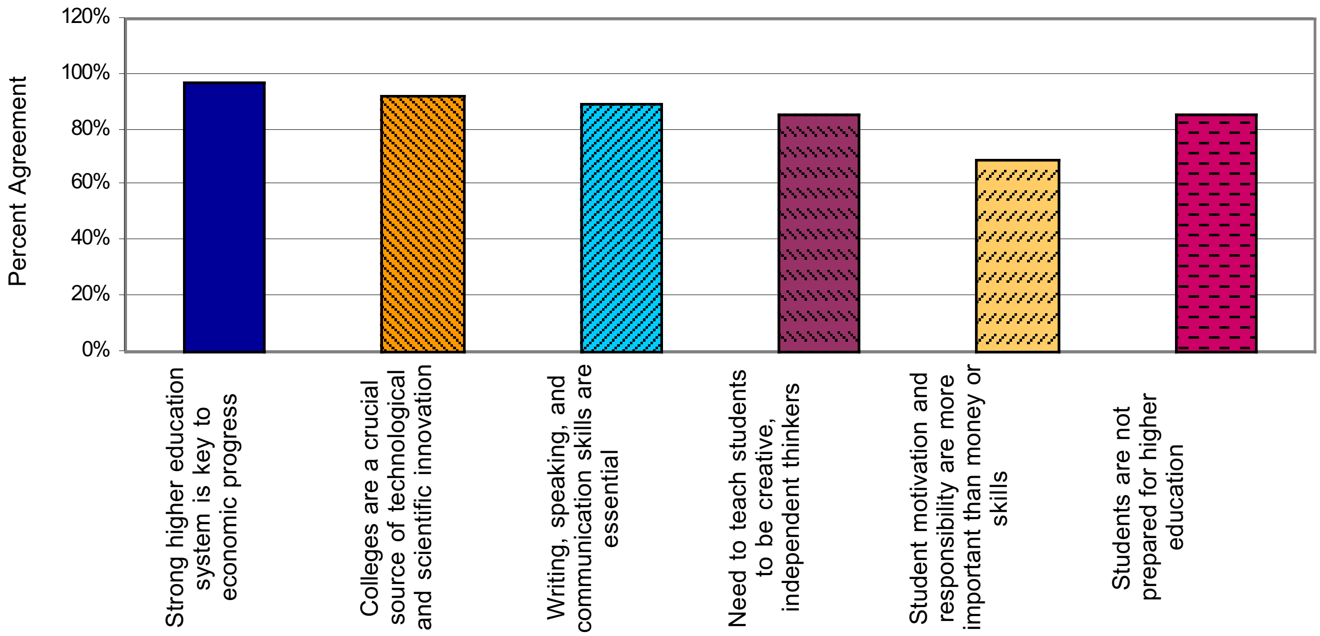

Figure 3. Areas of Consensus
Source: Immerwahr, Public Agenda Report, January 1999

2.2.2 Regarding Personal Skills

Student motivation and responsibility – academically, and in terms of a work ethic -- were identified as necessary skills.

Commitment to work, a work ethic, and a general preparedness for the work-world were identified as needed skills and qualities for a potential science and technology workforce.

This study found that from all of the personal skills that were identified as necessary, a majority of respondents (93%) identified having *a strong work ethic* and *commitment* to the job as being the most important skill currently needed. This finding was supported in follow-up interviews. There was a general perception that many employees who entered work organizations did not stay long because of their lack of preparedness for the rigors of the work-world in terms of the demands placed on them. It should also be noted that for many, both their position and duties were not what they expected, thus they became "disillusioned" with what they thought their work was "supposed to be."

It should also be noted that a survey by the Business Resource, Assistance, and Innovation Network (BRAIN) Plan also identified "work ethic" as being an area that required development.

A related issue to commitment and work ethic is that many new employees view their positions as "stepping stones" thus making little attempt to commit to their positions or to be loyal to their organizations. Still other new employees were reported as "soon wooed away" by other organizations and simply used their current employee's in-house training to their advantage. Many employees were described as having little patience or commitment for their beginning positions and expected advancement to higher position immediately. No mention was made by those being interviewed of whether the state of the labor market played a part in the employee's attitudes toward their beginning position.

The next set of findings address the skills and abilities perceived as lacking among current and new employees for science and technology firms and among students just graduating from the educational system.

Personal traits (consideration of others, self-confidence, physical and emotional health, etc.) were expected to be taught by parents and not necessarily by educational institutions.

Through informal interviews, the responsibility of who should be teaching these skills emerged. The majority of those interviewed felt that parents should be providing the necessary personal traits to help people obtain better positions in the workforce and for life in general. One interesting trend did emerge. It appears that the younger respondents felt that the educational system should be teaching these skills. However, among the older respondents there was a perception toward a more parent-centered responsibility. Personal skills were also identified by the Business Resource, Assistance, and Innovation Network (BRAIN) Plan as a skill area needing improvement.

2.2.3 Regarding Academic Skills

A majority of respondents identified that students were not prepared for the rigors of science and technology industries in terms of writing and mathematics.

Technical writing and computer skills were deemed extremely important by a majority of respondents.

Critical thinking and research skills were both identified as necessary and needed skills while foreign language and social studies were not seen as necessary.

Creativity, self-directedness, and teamwork were identified as high priorities.

Within the "academic skills" section of this study, five major skills emerged as being needed by employers. Through interviews these same skills were also identified and were perceived as not being taught sufficiently by the public education system. Eighty-Six percent (86%) of respondents identified skills such as basic mathematics, general verbal and writing, and general reading skills as sorely lacking among employees and current graduates. This finding not only has implications in terms of identifying a "new' phenomenon. In fact, if employer's current workforce is also lacking in these skills, this may indicate a longer-term problem that has existed in the educational system.

Through informal interviewing a picture emerged that pointed toward basic algebra as being extremely necessary. Students were seen as either doing poorly in basic algebra or as not have taken the course work at all. This criticism was not only directed toward the student -- but also the education system for not motivating students early on to want those jobs that might utilize this knowledge (i.e. positions in the fields of science and technology). Many organizations found themselves spending in-house training time or sending employees back to school to pick up skills "they were supposed to have gotten the first time around."

Another related issue was technical writing, which was rated as highly needed by employees. Without firm foundations in the basic skills employers are finding it increasingly difficult to teach the more advanced skills. A majority of respondents identified the inability to write technical reports as a major shortcoming among their employees.

Local economic development councils such as those in the Los Angeles County region and the South Bay back up these findings. For instance one-fifth of the companies responding to a survey put from the Business Resource, Assistance, and Innovation Network (BRAIN) Plan identified basic skills (such as reading, writing, and mathematics) as needed by area business. One-fifth also identified business and technical writing as needed.

Computer skills were also identified by a majority of respondents as being essential and highly needed by today's science and technology firms. This finding is supported by the aforementioned BRAIN Report which identifies over one-third of the respondents as saying that knowledge of computer software applications are needed and over one-third identifying that computer programming skills are needed.

Of all the respondents identifying needed skills in this study, 93% identified critical thinking as absolutely essential and needed for the work-world. This finding is also backed up by the BRAIN Report.

Among the identified non-academic skills, a majority of respondents (especially those in high tech firms) listed creativity, self-directedness, and teamwork as most important for the success of organizations in science and technology fields.

Further findings demonstrated that business and industry had tendencies toward which institutions should and should not be providing the needed skills of a prepared workforce.

2.2.4 Regarding Educational Institutions

The two main institutions perceived as best providing the necessary work and academic skills were high school and college/university.

In-House training was perceived as an important supplement -- but not a substitute -- for High School and University skills and preparation.

Community colleges and vocational schools were not identified as institutions to provide the necessary skills in preparing a potential science and technology workforce.

The survey results indicated that 86% of respondents identified high schools, universities and colleges as places for learning basic skills. Only 21% listed technical/vocational schools for any of the skills needed and 14% for community colleges. Clearly it was high school that was seen as the initial institution for learning the skills, and the universities for the skills to be further developed. This finding was mirrored in interviews where most respondents gave little attention to the role of community colleges and technical vocational schools. It needs also to be noted that 43% of respondents identified certain skills were best taught through in-house training, but as later elaborated in interviews clearly not a substitute for good foundations in high school and college.

Another aspect of this survey identifies high schools, colleges and universities as being perceived as best for providing needed skills. 79% of respondents listed high school and 71% listed college as the preferred recipients of hypothetical funding for teaching academic, personal, and career-oriented skills (29% listed in house training, 21% listed community colleges, and no respondents listed technical/vocational schools). In each case a majority of the hypothetical funding went toward teaching academic skills, except in the case of in-house training where the most funding went toward teaching career-oriented skills.

2.3 Limitations

One issue cannot be stressed enough regarding the nature of this study. In essence, what may matter most in conducting this study was the discovery of how difficult it was to obtain information regarding the needs of business and industry, as well as the state of the infrastructure about these needs. The efforts made here to obtain the data necessary to make informed conclusions yielded a smaller than expected return.

This smaller return highlighted an important conclusion: There are no readily available sources of information kept by businesses or state agencies. The bottom line is that *if business and industry is going to help the Kindergarten through University system, better information systems are essential*. The challenge then becomes the designing and implementing a non-intrusive system to provide the data to the educational system.

2.4 Summary Comments

Important at this point is to glean the essence from our survey findings, business and industry believes that:

- A stronger secondary and higher education system is needed
- There is an overall lack of student preparedness in writing and mathematics
- Motivation and responsibility (academically and as a work ethic) are highly needed
- Critical thinking and research skills are identified as very important
- Creativity, self-directedness and teamwork are indeed required
- Commitment to work is essential

The work of John Immerwahr (1999) in his Public Agenda Report, *Taking Responsibility: Leaders' Expectations of higher Education* offered many parallel and supporting findings (Please See Appendix A for review and analysis of the John Immerwahr study).

Immerwahr, in surveying over 600 professors, higher education deans and administrators, government officials, and business leaders came to some of the following findings (please refer to Figure 3 "Areas of Consensus"):

- "A strong higher education system is key to the continued economic growth and progress of the U.S." with 97% of respondents in agreement.
- 92% of respondents identified that "The nation's colleges are a crucial source of technological and scientific innovation.
- Approximately 66% of respondents identified motivation and responsibility as key -- namely that motivation and responsibility were more essential to students completing their education than were either money or skills.
- 89% of respondents identified the need for students to graduate with top writing, speaking and communication skills as absolutely essential.
- Also identified as "absolutely essential" (by 85% of respondents) was the need for teaching students to be creative, independent thinkers.
- Over 85% of all respondents identified most students as not prepared for higher education and as requiring remedial education.

To quote the John Immerwahr study, "What the leaders seem to be saying is that higher education cannot do the job alone; we cannot hope to produce an educated society without finding a way to produce large numbers of students who are sufficiently prepared and motivated to take advantage of the world's finest system of higher education." The only institution capable of meeting this challenge is K-12 Public School.

From direct communications with persons from the California State Department of Education (CDE), there is agreement on the need for increasing communications both within and between the systems of education. One of the prime objectives of these communications is to increase sharing of information between K-12, Community College, California State University, University of California, and Private educators to help build continuity and to help provide information, focus and direction to students.

Conversations with the California Department of Employment Development (EDD) have also identified the need for increased communications among educators, but also among business and education. These exchanges of information (and partnerships) are to ultimately help educators develop studies that integrate academics and work preparation, and for businesses to remain actively engaged in workforce development. The California Community Colleges are currently involved in development of integrated curricula, workforce development, and business partnerships.

One last note to address the strength of consensus on the above issues would be to report on some of the recommendations from the Association of American Universities (AAU) from their Task Force on K-16 Education Report (April 20, 1998). In the Interim Report Summary to the AAU Undergraduate Education Committee the Task Force reported that "Information technology has a pervasive impact on teaching and learning". The Task Force made recommendations and reinforced the need for increasing communications within and between K-12 and higher education and noted that university admission criteria needs to be linked (K-16).

3. Public School Infrastructure

3.1 Overview

The findings presented for *Phase II: Public School Infrastructure* are divided into two parts. The first part deals with what the CBEDS data analysis yielded regarding teacher credential, SAT9 test scores, and socio-economic status (SES). The second part involves findings based on interviews conducted with education and business representatives regarding teacher training, preparedness, and industry needs.

While relationships among teacher credentialing, SES, and SAT9 test scores are not exceptionally strong, they do represent a novel approach to identifying predictors of student performance by looking at teacher credentialing and SES. Although this represents a preliminary "rough" look by analyzing data among schools, rather then within each school, it is remarkable that this study was able to account for as much variability as it did. Thus, the analysis and data generated in this study is consistent with previous studies and reports on this subject and has yielded important insights into the needs of business, industry, and education as well as issues regarding the relationships among teacher credentialing, SES, and standardized test scores.

The major findings are cited below:

3.1.1 Part 1: CBEDS Data Analysis

- Socio-economic status is strongly related to SAT9 test scores. Schools that are economically better off consistently produce higher SAT9 test scores than those that are economically worse off.
- Socio-economic status is positively related to teacher credentialing. Schools that are economically better off consistently have better credentialed teachers than those that are economically worse off.
- Teacher credentialing is positively related to SAT9 test scores. Schools that have better credentialed teachers exhibit higher SAT9 test scores.
- School population size is positively related to SAT9 test scores. Schools with larger populations tend to exhibit lower SAT9 scores.
- School population size is positively related to teacher credentialing. Schools with larger populations tend to have worse credentialed teachers. (See Table 1.)

3.1.2 Part 2: Interviews with Education and Business

- There currently are many programs within our educational system integrating career needs, curricular changes, and staff development.
- The need does exist for connectedness between business and education.
- There does exist a need for greater collaborative efforts within and between programs, institutions, and contexts.
- Businesses do seek employees with not only the necessary technical skills, but also with the abilities to be innovative, self-motivated, and to solve problems.

3.2 Areas of Consensus

The following is divided into two parts: the first is a discussion of the findings of the current CBEDS data analysis. The second relates the findings of the education and business interviews to similar findings of other studies and reports. These "areas of consensus" are presented to help strengthen the argument that teacher credentialing, knowledge of the subject matter, and student motivation as important means to higher achievement and better preparedness in the science and technology workforce are consistent with other studies that have focused on this subject matter.

3.2.1 Part 1: CBEDS Data Analysis

This first part will discuss the three major findings produced from data analysis on the California Basic Educational Data System (CBEDS). This data is self-reported and attempts to capture information from every teacher in the state. This analysis represents a rough picture of the current situation on California's high schools with regard to teacher credentialing in math and science, socio-economic status, and SAT9 standardized test scores. Although a more detailed discussion of the data analysis procedures can be found in the "Research Design and Methodology" section of the report, a brief discussion of how each finding was made will be discussed along with its significance will now follow.

> *Socio-economic status is strongly related to SAT9 test scores such that those schools that are economically better off consistently produce higher SAT9 test scores than those that are economically worse off.*

This first finding is a reflection of SAT9 Scores taken from the 100 best credentialed schools and the 100 worst credentialed schools. By "best credentialed" is meant that teachers who are fully credentialed to teach and have a secondary specialization in math or science. "Worst credentialed" means that the teacher is not credentialed to teach (emergency waiver, internship, etc.) and do no have the secondary qualifications to teach a math or science course. The average SAT9 score was taken for these top and bottom 100 schools in both math and science.

Taking this average test score as the dependent measure, a linear regression was run with two independent measures of socio-economic status (SES): (1) Percentage of children in the school on Aid to Families with Dependent Children (AFDC), and (2) Percentage of children in the school on the Federal Free School Lunch Program (FSLP). Taken together, 46 percent of the variability in average SAT9 scores were explained by economic factors (R^2 = .46) for math; and 70 percent of the variability in average SAT9 scores were explained by economic factors (R^2 = .70) for science. Thus, SES is a good predictor of a child's SAT9 test scores in math and science.

Socio-economic status is positively related to teacher credentialing such that those schools that are economically better off consistently have better credentialed teachers than those that are economically worse off.

This second finding, while not as strongly supported still yields interesting and important information regarding the affect that socio-economic status can have on where the better credentialed teachers end up teaching. For this finding, the average teacher credentialing variable was taken as the dependent measure and a linear regression was run with the two socio-economic variables as independent measures. The teacher credentialing variable was created by making a one to four scale -- with one being the best credentialed teacher and four being the worst credentialed teacher – then looking at the average per course credential for each school.

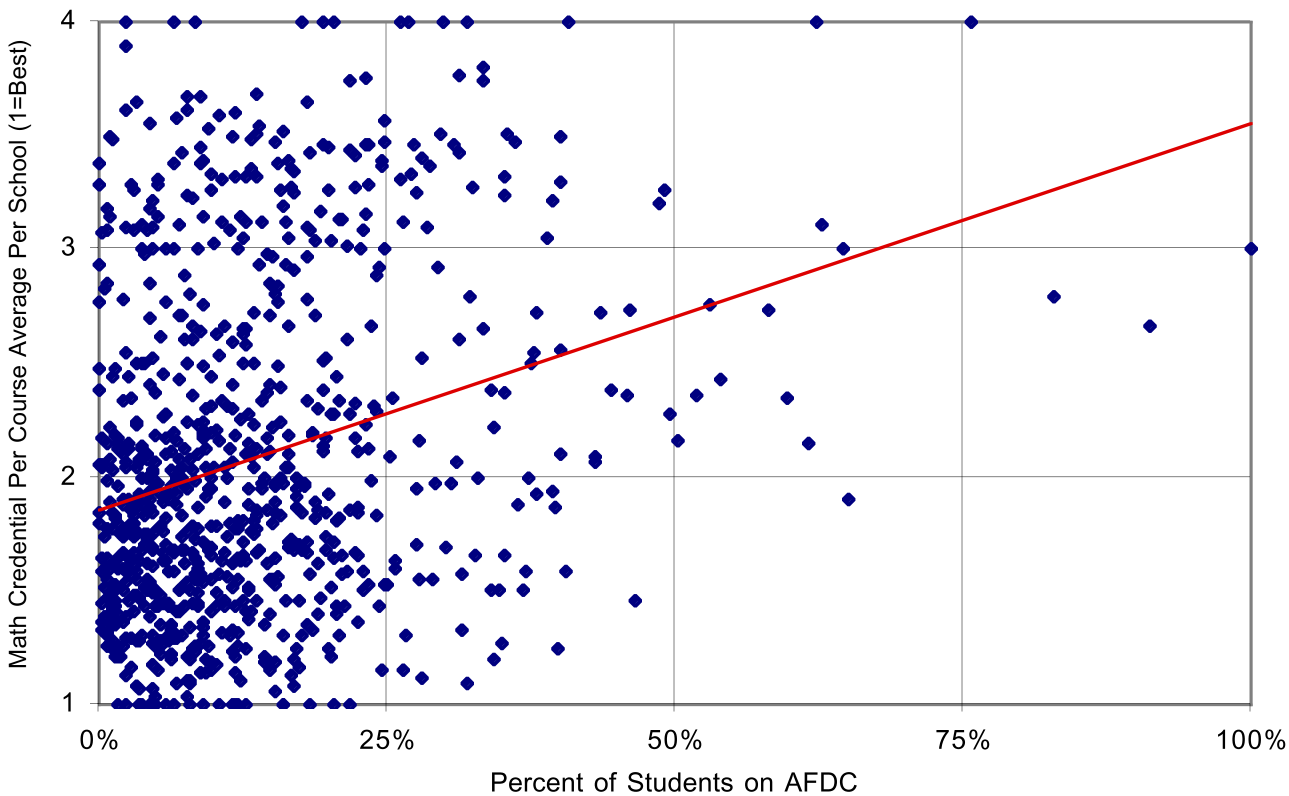

Figure 4. Plot of Math Teacher Credentialing on AFDC

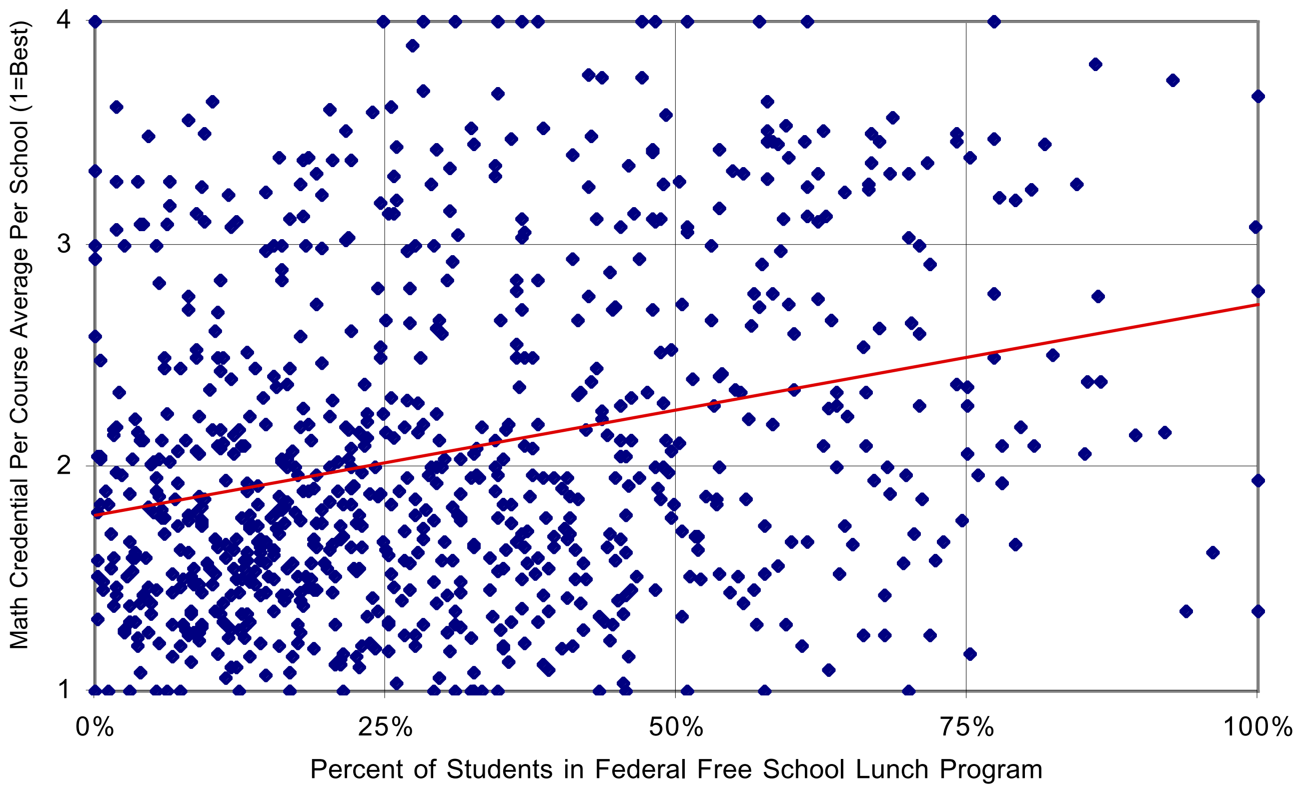

Figure 5. Plot of Math Teacher Credentialing on Free School Lunch Program

This finding is not as strong, but is nonetheless positively correlated at the .001 probability level. When a regression was run, it was found that taken together, 11 percent of the variability in average per course teacher credentialing was explained by economic factors (R^2 = .11) for math; and 12 percent of the variability in average SAT9 scores were explained by economic factors (R^2 = .12) for science. Thus, the SES of a particular school is a predictor of what type of credentials and training a teacher has in math and science.

The distributions in Figures 4 – 7 represent scatter plots of the distribution of credentialed teachers to SES. As stated earlier, SES consists of an AFDC component and a Free School Lunch Component. The credentialed teacher component is made up of the per course teacher credential averages per school.

Teacher credentialing is positively related to SAT9 test scores such that schools that have better credentialed teachers exhibit higher SAT9 Test scores.

Again, this particular finding is not as strongly correlated, yet it still generates some interesting results in terms of the importance of teacher credentialing in math and science as a predictor of SAT9 standardized test scores. It nonetheless is positively correlated at the .001 probability level. To reiterate this represents a preliminary "rough" look by analyzing data among schools, rather then within each school, therefore, it is significant that this study was able to account for as much variability as it did.

When a linear regression was run with a free float of all the variables (SES, School Population, and Teacher Credentialing) teacher credentialing was statistically dropped due its small impact in the face of SES. But if a force is performed and a linear regression run where average per course teacher credential is forced in first, then SES, then school population, the effects of teacher credentialing appear. The issue here is the covariation of credential quality and SES, this in turn leaves little unique variance for the teaching credential quality variable. But it does reveal a relationship. Thus, forced in first, it accounts for 12 percent of the variability of SAT9 test scores (R^2 = .12) in math, and it accounts for 21 percent of the variability of SAT9 test scores (R^2 = .21) in science.

The last set of findings deal with the size of the school in terms of the school's student population. Again, while not overly powerful, school population does represent a relevant predictor of both SAT9 test scores and where better credentialed teachers may be found. School population is both positively correlated with SAT9 test scores and teacher credentialing at the .001 probability level.

School population size is positively related to SAT9 test scores such that those schools with larger populations tend to exhibit lower SAT9 scores.

School population size is positively related to teacher credentialing such that those schools with larger populations tend to have worse credentialed teachers.

Running a linear regression with the average SAT9 test score as the dependent measure and school population as the independent measure yielded little variance explained, the same occurred with school population and teacher credentialing. (See Table 1.)

3.2.2 Part 2: Interviews with Education and Business

Interviews with local business, educational, and administrative persons were established and set up in a 'think tank' type format. Group discussions and group interview were built around the question of "what, if anything, can high school teachers bring into the classroom to help students to identify and prepare for career opportunities after completing their post-secondary education?" The discussions have yielded many interesting and at times somewhat anticipated findings.

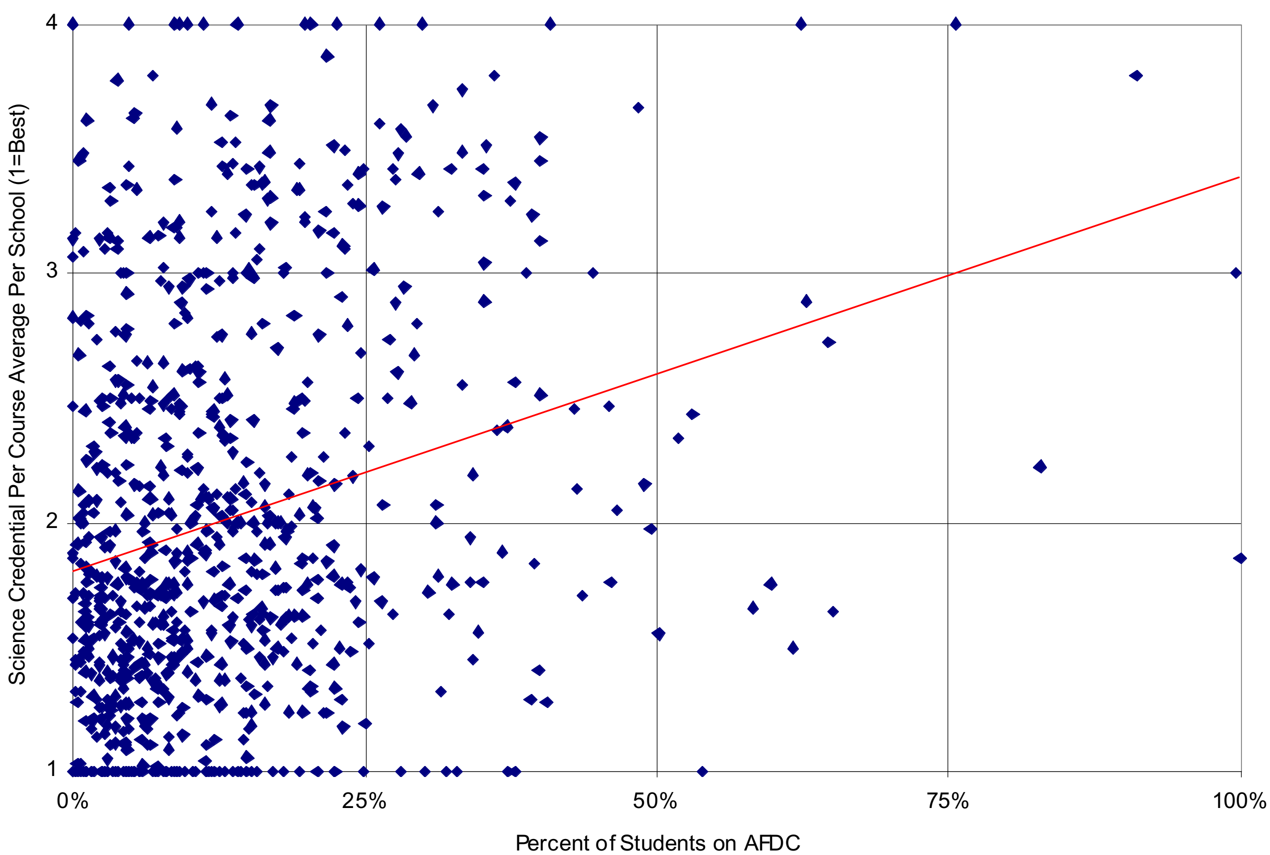

Figure 6. Plot of Science Teacher Credentialing on AFDC

There currently are many programs within our educational system integrating career needs, curricular changes, and staff development.

There are many comprehensive programs already under way to integrate rich science and mathematics curricula within schools and districts. The already exists many integrated staff development programs, which incorporate curricula content changes as well as off-campus opportunities for teachers to obtain first-hand experiences with potential and available high-tech careers.

The need does exist for connectedness between business and education.

There does exist a need for greater collaborative efforts within and between programs, institutions, and contexts.

As stated earlier in this report, there still exists the need for a more comprehensive 'needs database' as informed by business and industry, as well as continuing and comprehensive linking to classroom instruction and activities. The recent interviews support the findings and recommendations from the California Department of Education -- namely that there exists the need for increased collaboration among K12, Community Colleges, Colleges, Universities, and Businesses. Their collaborative efforts could focus on increased information sharing and increased availability of resources to students.

Businesses seek employees with not only the necessary technical skills, but also with the abilities to be innovative, self-motivated, and to be able to question outcomes and solve problems.

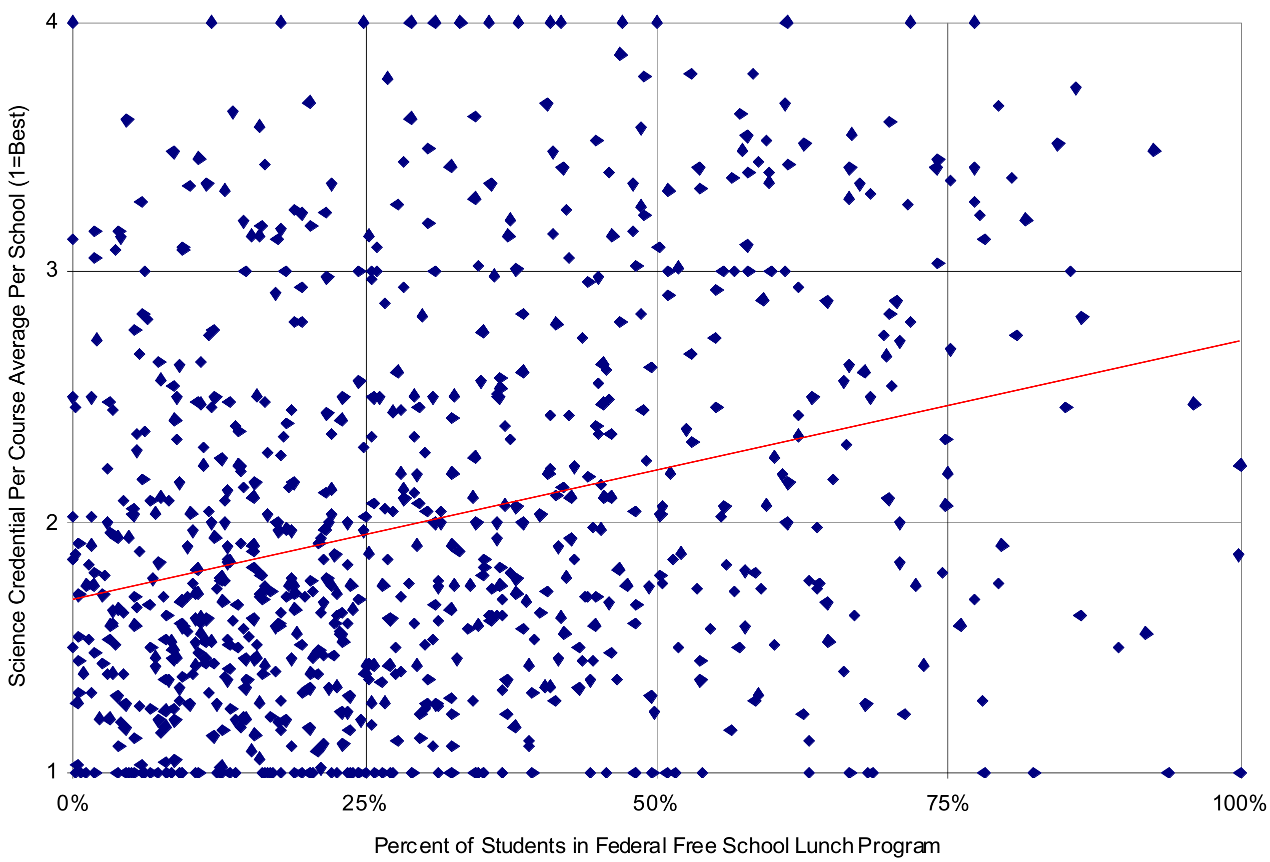

Figure 7. Plot of Science Teacher Credentialing on Free School Lunch Program

Table 1. Means and Standard Deviations for Independent Measures on Dependent Measures

		SAT9				Average Credential per Course Avg.			
		AFDC	Free Lunch	School Population	Cred. Per Course Avg.	AFDC	Free Lunch	School Population	Avg. Class Difficulty Level
Math	Mean	14.26	31.53	1443.43	2.21	13.10	30.58	1706.18	2.52
	Std. Dev.	14.07	21.67	914.76	1.11	12.37	21.95	896.42	.26
Science	Mean	13.86	34.35	1415.49	2.13	13.12	30.21	1743.16	2.08
	Std. Dev.	13.52	22.76	864.58	1.18	12.82	21.78	873.47	.39

The need exists for a better understanding of the types of science and mathematics education programs and staff development programs already in existence and practice within California schools. There is a lot of good work already in place, but benefits could apparently arise from a greater understanding of the programs currently available and not available, and from contextual evaluations of effectiveness (both in and out of the classroom).

3.3 Summary Comments

The statistical analysis from the CBEDS yields three major points:

- Schools that are economically better off consistently produce higher SAT9 test scores than those that are economically worse off.
- Schools that are economically better off tend to have better credentialed teachers than those that are economically worse off.
- Schools that have better credentialed teachers tend to exhibit higher SAT9 test scores.

Interviews of business and industry reveal that:

- There currently are many programs within our educational system integrating career needs, curricular changes, and staff development.
- The need exists for an increased connectedness between business and education
- There does exist a need for greater collaborative efforts within and between business and educational programs, institutions, and contexts.
- High-tech businesses seek employees with not only the necessary technical skills, but also with the abilities to be innovative, self-motivated, and to problem solve.

One possible medium to support the need for education to be better informed about actual business needs and demands, would be for business to actively keep some type of database system for logging those needs (similar to the CBEDS database in education). Other potential mediums for integrating career information into classrooms could be site visitations from business persons, first-hand career experiences for teachers as well as students, staff development built around curricular and programmatic changes, etc. Therefore in support of the need for greater collaboration and communication, further exploration of the availability, context, and effectiveness of programs and interventions continues to be warranted and needed.

It should be noted that in June 1999, the U.S. Department of Commerce Technology Administration (USDCTA) released a report titled, *The Digital Workforce: Building Infotech Skills at the Speed of Innovation*. Some of there more important conclusions -- and of particular relevance to the second phase of this project – is that the education system (especially universities and colleges) should:

- Work together with industry and government to support and develop national information and advertising campaigns to improve the image of the technical professions, and communicate the portfolio of skills needed to thrive in the new economy.
- To encourage incumbent worker training, create greater flexibility in IT training, including offering shorter courses, increasing the variety of course times and locations, and expanding the use of tele-training.
- Examine the adequacy of the teaching infrastructure for four-year and two-year IT-related degree programs (seats, equipment and faculty).
- Retain qualified IT teachers through competitive pay and other benefits. Faculty who obtain IT certifications should be rewarded for their achievement as a way to retain them in teaching.
- Find much faster ways to upgrade curricula through regular surveys of skills needs, ongoing dialogue with IT business leaders and technical professionals, and more monitoring of the business environment and technological trends.
- Bring faculty to industry through exchange programs for industry and university scientists and engineers. Encourage faculty to establish relationships with counterparts in high technology industries.
- To improve the education of K-12 teachers, encourage collaborations between schools of education and college math, science and engineering departments. Create and implement IT curricula in schools of education.

- Develop partnerships between science and technology departments, and business schools to provide business majors and MBAs with technical skills, and offer people graduating in non-IT fields some courses in IT.
- Provide hands-on opportunities for students to gain real-world experience in high technology industry and technical careers. Bring professionals with real-world experience into the classroom at all levels.
- Aggressively recruit women and minority faculty for science and technology programs at the K-12 and college levels.

4. Conclusion

One valuable outcome of this study is that it has begun to design a survey system that might be useful for identifying many of the needed workforce preparation elements. This study has provided a basic groundwork for the identification of perceptions among those in the science and technology industry in respect to workforce development and needs. While this study is not yet complete, the use of data from other surveys and organizations has helped to establish an initial picture on the current state of which skills and abilities are being desired and which are still requiring development.

It is only hoped that the information being provided in this study will help to inform both public and private policy in order to make a stronger and more competitive workforce, economy, and society. First, once those in the education system -- especially teachers -- have a better idea what it is that industry needs, both teacher and student preparedness for the rigors of a well-rounded curriculum are within grasp. This may most readily manifest itself in changes in curriculum and competency requirements. Second, once industry is better able to articulate its needs, and receive a well-educated graduate pool, the economic and social benefits will emerge. One immediate possibility is the previously mentioned information system implemented across industries to continuously gather data on the changing demands of the workplace as well as what skills are lacking among those entering. The possibilities for effective restructuring within our system of education include comprehensive teacher education, allignment of integrated curricula to careers, effective communications between institutions, and appropriately availing the information to the students.

4.1 Policy Recommendations

A strong recommendation is made even at this point in this study to encourage businesses and industries to begin maintaining in-house databases that seek to identify site- and industry-specific workforce "needs' and to examine how well those needs are being met. To this end, a strong communications link between industries and schools would be a major step in providing constant access and information between these two dependent institutions.

This project (coupled with its ability to tap into changing workforce needs and demands to help better prepare a competent and innovative workforce) provides necessary and timely indicators for business, industry, and education. We invite you to examine and review this project at: http://ccst.ucr.edu.

4.2 Recommendations for California

On May 26, 1999 this Education and Workforce Report (Phase I) was presented to the CCST Council in Long Beach, California and included the following recommendations to the Governor as deliberated by the CCST Council:

The key question is: *What can be done to improve California's workforce infrastructure for Science and Technology?*

California needs a clearer and more trustworthy picture of industry needs and resources

- Develop a timely and comprehensive needs assessment system from business and industry - a California Basic Educational Data System (CBEDS) equivalent providing survey information from Science and Technology businesses

California needs to build a coherent program of Science and Technology schooling to meet tomorrow's needs

- Coordinate legislative and administrative curriculum, instruction, and assessment programs to ensure K-12 science, math, and technology programs meet the full range of needs

California needs to ensure that tomorrow's generation of teachers in math, science, and technology are an adequate and effective foundation for improved instruction

- Insist on higher standards and the end of emergency permits and "patches" and encourage National Board for professional Teaching Standards (NBPTS) certification
- Enhance recruitment, preparation, and ongoing professional support for Science and Technology teachers, including in-service and post-graduate programs
- Enact legislative penalties for out-of-subject teaching assignments
- Require every certified high school teacher to have multiple certification

California needs to inform high school students about Science and Technology careers

- Create University and Business connections with high schools
- Require science, math, and technology teacher preparation to include some experience in career linkages for students

5. Research Design and Methodology

5.1 Phase I

In terms of this study's research design, two facets were critical for this project -- the sites and the survey instruments. The CCST plan called for the investigation of three high-tech industries: Aerospace, Biotechnology, and Telecommunications. For logistical reasons, the sites selected were Southern California-based. The selection criteria itself encompassed a wide variety of industries -- large and small, corporate and private, well established and relatively recent.

The initial tasks of this project included four major aspects:

- Investigate the demand for a skilled workforce by industry sectors that include the Aerospace, Biotech, and Telecommunications fields. A total of five firms were selected.
- Develop and administer a survey and interview instrument that is designed to categorize the perceived needs at all organizational levels by gathering data through vertical slices. Structured interviews of selected participants were conducted to obtain a fuller picture of survey responses.
- Obtain quantitative data on the case study firms' high tech "people" needs. Thus the gathering of data provides insights into what drives these resource needs. Sources for high-tech personnel who have been hired were identified.
- Analyze the data with the objective of developing a coherent portrait of industry needs that reveal common themes along with variations.

This study reports the views of Owners, CEOs, Managers, and Human Resource Managers of Science and Technology firms in the Southern California area. The companies used in this study represent firms ranging from one to over a five thousand employees.

All participants responded to a mail survey conducted in the winter of 1998 and an on-line survey in the spring of 1999. The distribution of questionnaires was achieved in two ways: First the California Council on Science and Technology delivered an invitation to participate along with the questionnaire to the leaders of organizations, who then distributed the surveys (See Appendix B) to a sample of individuals. Second an on-line version of the questionnaire was posted on the CCST web site allowing other respondents to post their responses.

The data collected reflects responses obtained through an initial pilot study.

The breakdown of respondents is as follows:

- Owners/CEOs: Two Owners/CEOs from major Southern California Bio-Technology firms
- Managers/Team Leaders: Three team leaders from leading Aerospace and Telecommunications firms in the Southern California area
- Human Resource Managers: Ten human resource managers from a major Southern California Aerospace firm

The initially questionnaire was presented to an organization leader who directly had the capacity to distribute to other respondents in the firm. The interview obtained from that participant aided in an understanding of the goals and employee make-up of the company, as well as perceptions on the survey's questions.

The initial distribution of the questionnaire was on November 02, 1998. Mailings were followed soon after by email and follow-up phone reminders. The on-line questionnaire was created in January 1999. A total of 80 paper-based questionnaires were distributed. Due to the groundbreaking nature of attempting to gather employee data from business and industry, we unfortunately found our initial response rate to be low (15%). Thus an on-line component to the survey was created to help generate more data. All data in this report are based on questionnaires returned by January 15, 1999. The paper-based distributions resulted in a total of 14 returned questionnaires.

Design of the survey instrument was done by Calfee, Levy, and Fleisher and was based on previous instruments that were designed to measure attitudes regarding perceptions of business needs and the related educational issues of meeting those needs. The academic and career research of John Krumboltz at Stanford University (1986) was instrumental in the creation of this survey instrument. Several open-ended questions were included in the survey to provide more in-depth detail to supplement the respondents' answers. (For the entire survey instrument see Appendix B).

All interpretation of the data in the report was done by Calfee, Levy, and Fleisher.

5.2 Phase II

5.2.1 Part 1: CBEDS Data Analysis

Research Design. The first stage of this work was to assemble in compact form several sources of existing data. For instance, the California Department of Education (CDE) has compiled information about SAT9 standardized test scores in recent years as well as the California Basic Educational Data System (CBEDS).

The State data do have some shortcomings, to be sure. They constitute unverified reports by teachers of their teaching assignments and student characteristics and by administrators of various facets of the school context. Data are not available on individual students. Nonetheless, the data will allow us to assess several hypotheses about the middle-high school pipelines. Examining variations among districts and schools based on overall demographics should also offer insights into the present state of affairs. For instance, we looked at what ways do schools and districts serving high- and low-SES communities vary in the level of course and teacher qualifications in science and math.

Based on these findings, we designed interview protocols for approaching several local districts and high schools, to obtain more in-depth and validated perspectives on how the system is operating. The Inland Empire offers an unusual chance to examine a system under reform because of the intense outreach activities in place during the past few years. Local districts and the University have given particular attention to tracking the progression of students through the high school years onto a "UC-eligible track," and thence through the application and admission routes.

CERC (the California Educational Research Collaborative located in the School of Education) has constructed a ten-year data base of CBEDS records that have been "cleaned" and prepared as an SPSS file; we gained access to this data base for exploratory analysis of course-taking trends across time for the entire State. Merging the recent SAT9 scores with these data is relatively straightforward, allowing a school-level analysis of relations between teacher/course resources and standardized student achievement. Recognizing the numerous problems in this level of aggregation, the analysis does nonetheless offer some insights into trends

In a summary, this is what was done with the data:

Analyze CBEDS data regarding the *nature of the quality of education in the K-12 system*.

a. A comparative analysis was done with existing data as mentioned above
b. Major trends were extracted from current CBEDS analysis focusing on one time period -- 1997
c. Variables to be analyzed in this data focused on the following areas:
    i. Teacher credential areas
    ii. What courses teachers are teaching versus those areas they are actually trained in
    iii. Region / Socio-economic Status (SES) as it pertains to qualified teachers and students prepared for rigors of science and technology fields
d. SAT-9 tests scores as they relate to region, and student taught by qualified/unqualified teachers based on credential orientation

Methodology. Analysis of the CBEDS Database was done using SPSS version 9.0, and includes the presentation of several types of statistical analysis. To begin with new variables had to be created from the existing data that better captured the information that we were trying to obtain. For instance, variables that focused on math and science credentialed teachers were created by constructing a variable composed of the type of credential a person held and if that particular person was teaching a math or science course. In this way we could create a rubric of best to worst credentialed teachers per courses that they taught.

Another variable that was created from the existing data set was based on the type of math and science courses taught at each school – from advanced to basic. Lastly, a variable was created to find the average math SAT9 score and average science SAT9 score for each school. SAT9 scores were obtained for the top 100 schools with the best-credentialed teachers in math and science. Best credentialed meant that they were fully credentialed to teach and had a secondary specialized credential in math or science. SAT9 scores were then obtained for the bottom 100 worst credentialed teachers. Worst credentialed meant that they held less than full credentials or none at all. They also had no secondary specialization in math or science. SAT9 scores were obtained this way due to the limitation in the format that they were presented to us, which ultimately affected the way they were merged into the CBEDS database. Other variables that were used came provided in the data set; these included the school's population size (measured in student totals) and SES measures (AFDC and Federal Free School Lunch program).

Once the variables necessary were created, the data file was aggregated to the school level. For the science focused, this yielded a data set of 821 schools, for the math focus, a data set of 838 was created. The CBEDS data comes as an information file compiled of teacher self-reported information. In order to make the data more meaningful, especially in terms of across school comparisons, the data were collapsed into school-level. This collapsing of data meant that average credential quality and average class type would be used in the analysis, instead of individual teacher-to-student-to-test score. This limitation makes the relationship weaker between teacher credential and SAT9 score and SES, but does not obscure the relationship completely. In fact, if scores were to be obtained for individual students, or by the teachers who taught those students, we are confident that a stronger relationship would emerge.

After the aggregations (one for math and one for science) were completed, a zero-order correlation matrix of independent and dependent variables was run to look for significant relationships. Once identified, a linear regression was run to test for the expected predictors of student performance (SAT9 scores) and Teacher Credentialing.

5.2.2 Part 2: Interviews with Business and Education

Three 'think tank' type group interviews were set up during the month of July 1999 at the School of Education at the University of California, Riverside. Hi-Tech business persons (owners and managers), ducational persons (higher education faculty, program directors, administrators, district personnel, school personnel, teachers and practitioners) were contacted.

Contacts were made by way of an initial letter of invitation sent via mail. Respondents were grouped into one of the three scheduled meeting dates and times based upon respondents' convenience and availability. The actual group meeting was conducted accordingly: (1) introductions and project background discussed, (2) group discussions and interviews. The interview questions were structured in a funnel-type format beginning first with a broad, open-ended question, "What if anything could high school teachers bring into their classrooms to better inform and engage their students about careers available to them after having completed their post-secondary education?" The following categories were then presented as a framework for further discussion: applied curriculum, teaching personal skills, teacher education and training, trouble shooting, data needed, graduation requirements and college entrance. (See Appendix D for Interview Protocol).

6. Acknowledgements

All of the Participants from Business and Industry

Alvord Unified School District

American Electronics Association (AEA)

Association of American Universities (AAU)

Business Resource, Assistance, and Innovation Network (BRAIN) Plan

California Department of Education (CDE)

California Department of Employment Development (EDD)

California Community Colleges (CC)

California Council on Science and Technology (CCST)

California Educational Research Cooperative (CERC)

Council of Chief State School Officers (CCSSO)

Council on Competitiveness

Desert Sands Unified School District

Inland Empire Economic Partnership (IEEP)

Los Angeles County and South Bay Regions

National Science Board (NSB)

National Science Foundation (NSF)

Riverside Unified School District (RUSD)

South Bay Economic Development Partnership (SBEDP)

Sandy Jacobs, Mayor Pro Tem of El Segundo

San Bernardino County Superintendent of Schools (SBCSS)

Secretary's Commission on Achieving Necessary Skills (SCANS)

Joe Aro and Tod Sword of SBEDP

John Immerwahr and Public Agenda

University of California at Riverside (UCR)

U.S. Department of Commerce

7. Appendix A: Immerwahr Public Agenda Report (Review and Analysis)

Taking Responsibility: Leaders' Expectations of Higher Education
By John Immerwahr, January 1999
Conducted and Reported by Public Agenda
For The National Center for Public Policy and Higher Education

Question. The report addresses the question, "What are the concerns of those most involved with decision-making about higher education, and what do they see for the future?"

Method. A mail survey was conducted across the United States. Responses were received from 601 business, government and education professionals (professors, higher education deans and administrators, government officials, business leaders). Questions were asked in the following areas:

- Problems Facing Colleges. Things that may or may not be problems and how serious

- Access to College: The View of Leaders and The View of the Public
- Impact of Technology. Tenure. Improvements. Attendance.
- Comparison of Today's Colleges. Now versus ten years ago
- Curricula. Costs. Responsibility for Paying. Opportunity.
- The Goals of a College Education. Droupout Rates.
- Attitudes Toward Colleges and Higher Education.
- College as Compared to Business Efficiency.

Returned survey questionnaires were obtained from 130 college professors, 163 college administrators and deans, 146 businesses, and 162 government officials. Responses were averaged and tallied per specific questions and levels. Percentages in the "Total" of all respondents categories were each weighed and averaged against a count of 150.

Results. The report was delivered in a synopsis and report format, not necessarily as a formal research report and analysis. Response percentages from each of the different respondent groups (professors, college administrators and deans, government officials, business leaders) and totals were tabled and provided for each of the question groups (Problems Facing Colleges, Access to College, Impact of Technology, etc.).

Interpretation. The interrelatedness of business and education was addressed. In many respects business leaders noted the need for systems of education to become more efficient, while many education professionals tended to be more focused on education content issues rather than functional efficiency. However there was a common ground that remained constant – business leaders and education professionals agreed on the lack of preparedness of students entering higher education.

8. Appendix B - CCST Survey Instrument

California Council on Science and Technology Needs Assessment Survey

Thank you for taking time to fill out the *California Council on Science and Technology Needs Assessment Survey*. Our goal is to assess the needs of growth industries such as those found in the biotechnology, aerospace, and telecommunications fields. By discovering the needs and skills required of these important industries, we are better able to prepare the educational system to meet those needs.

The following survey consists of two pages (both front and back). The survey itself should take no longer than 15 minutes to fill out. Aside from filling out the survey, we ask that you make comments (if you feel necessary) in the margins to any aspect of the survey that you find lacking or needing of improvement. To better match industry needs with the educational system, it is important that we ask the "right" questions. Your participation in this survey will help us to shape the best possible measuring instrument.

It will probably be some time before all the information is processed and initial drafts of reports written. Please feel certain that your name, or the name of your company, will never be used in any report or publication using information obtained from this study.

Because we may require follow up interviews, or simply clarifications, we ask that we be able to contact you again. If we may contact you again, please sign the consent form and provide contact information below. Remember this survey is completely voluntary and you have the right to refuse participation at any time. Again, we assure you that all information and individuals will be kept in strict confidence. All surveys will be coded such that the consent form will be kept separate from the actual survey responses. To ensure further confidentiality, individual respondents will mail back their completed surveys with the included self-addressed stamped envelope.

All of us at the California Council on Science and Technology agree that the success of this project is owed primarily to the cooperation of people such as you who have taken the time to participate. Thank you very much.

Should you have any questions at all regarding this study, please feel free to call Dr. Robert Calfee, project director, at (909) 787-5802, or Charles Levy, research assistant, at (909) 787-5444, or the Human Subjects Review Board at the University of California, Riverside, at (909) 787-5535.

California Council on Science and Technology Needs Assessment Survey

Thank you for your participation in this survey designed to identify and assess the current skill needs (academic, personal, and career) for industry; and how well those needs are being met.

Instructions: Sections I - III of this survey are divided into two halves.

(1) The first half deals with Skills and Abilities that are *needed* in your organization and Skills and Abilities that are actually *received* in your organization. Please rate the following skills and abilities for each of the given categories (Skills Needed and Skills Received on a scale of 1 to 5 (1=Most and 5=Least).

(2) The second half deals with your opinion on *whose responsibility* it is to provide for that skill or ability. For the following skills and abilities simply check the box of the organization you feel should be providing for the skill or ability.

Skills/Abilities	Rate on a scale of 1 to 5 (1 = Most and 5=Least)			Please check the box of the organization you feel should be primarily responsible for the skill or ability				
I. Academic	**Skills/ Abilities Needed**	**Skills/ Abilities Received**		**High School**	**Technical/ Vocational School**	**Community College**	**College/ University**	**In-house Training**
1. General Science								
2. Mathematics								
3. Computer Science (General)								
a. Use of Applications								
b. Programming								
4. Verbal (General)								
a. Technical								
5. Writing (General)								
a. Technical								
6. Reading/Comprehension (including Technical)								
7. Critical Thinking (problem solving, decision making, objectivity)								
8. Research Skills								
9. Foreign Language								
10. Social Studies								
11. Other (Specify): _______________								
II. Personal								
1. Consideration of Others								
2. Physical and Emotional Health								
3. Self-Confidence / Coping Skills								
4. Works well with others								
5. Listening Skills								
6. Flexibility								
7. Work Ethic (hard working, responsible)								
8. Commitment								
9. Takes Initiative								
10. Knowledge of Current Events								
11. Other (Specify):_________________								

PLEASE TURN OVER FOR ADDITIONAL ITEMS

Skills/Abilities III. Career	Rate on a scale of 1 to 5 (1 = Most and 5=Least)			Please check the box of the organization you feel should be primarily responsible for the skill or ability				
	Skills/ Abilities Needed	Skills/ Abilities Received		High School	Technical/ Vocational School	Community College	College/ University	In-house Training
1 Goal Directed								
2. Planning Skills								
3. Decision-Making								
4. Competitiveness								
5. Use of Transferable Skills								
6. Ability to Develop Opportunity								
7. Creativity and Inventiveness								
8. Self-Directedness								
9. Ability to work in teams/Teamwork								
10. Interview Skills								
11. Other (Specify):________________								

IV. Spending Grid

Instructions: Imagine being given a $100 budget to spend on developing skills and abilities needed for your organization. Please appropriate the money accordingly into the given categories (based on the three categories [I-III] above) depending on which institution (high school, technical or vocational school, community college, college/university, or in-house technical training) should provide for skill and/or training development opportunity.

	High School	Technical/ Vocational School	Community College	College/ University	In-house Training
Academic					
Personal					
Career					

Please explain your rationale for the choices in the above appropriations. We are especially interested in the areas of greatest need for your organization (as identified in Sections I - III above), and how you are focusing or would focus your training to meet those needs.

V. Perceived Contributions

Please indicate the kinds of contributions by both educational and industry that you think would help in preparing the workforce for jobs in the science and/ or technology field. In addition to the above, what do you feel is actually going on at the educational and business levels to prepare the workforce for science and technology occupations?

VI. Demographic Information

1. Male _____ Female _____

2. Age _____

3. Education (Please indicate the furthest education you have attained):

Some High School
High School
Some Community College
Community College
Some Technical/Vocational School
Technical/Vocational School
Some College/University
College/University

4. What is your position with the organization? ____

5. What is your title? _______________________________

6. How long have you been (years and months) with your organization? __________

7. Did you go through a training procedure in your organization? Y N

8. Are you in a position to train employees? Y N

9. Where did you receive the skills for your current position?
   a. High School
   b. Community College
   c. Technical/Vocational School
   d. College/University
   e. In-House Training

9. Appendix C - Industry Interview Questions

I. Elaborate on selected *skills*

A. What is perceived as important and not important -- why?

1. Academic, Personal and Career

II. Which *institutions* should be providing which skills and why?

A. Family, High School, College/University, Community College, Vocational School, or In-House

III. What are the most important areas needed in *training*?

IV. The role of *education* (in terms of Science and Technology)

A. Contributions toward workforce

B. What would you do to change it?

C. What is the biggest problem?

D. What would you tell Governor Davis regarding education?

V. *Industry* Responsibility

A. What should industry be doing to aid in a more prepared workforce?

B. Kinds of training, etc.

VI. Employer *Perceptions* of Employee (Foreign and Domestic)

A. Kinds?

B. Attitudes?

C. Weaknesses and Strengths (largest and smallest)

D. What would you change?

VII. Own experiences in work world

VIII. Additional Comments

10. Appendix D - Interview Questions and Protocol for Roundtable Discussions:

I. *Introductions*

II. *Discussion of Project and Project Framework*

Dr. Robert Calfee, Dean, School of Education, UCR

Charles Levy, Department of Sociology, UCR

Steven Fleisher, School of Education, UCR

Review of Project Summary

III. *Group Interview / Discussion Questions*

Opening Question:

What can high school teachers 'bring' to their classrooms to help inform and engage students regarding careers after they have finished their post-secondary education?

Categorical Question Areas:

A. *Applied Curriculum*

B. *Teaching Personal Skills*

C. *Teacher Education and Training*

D. *Troubleshooting*

E. *What Data Do We Need*

F. *Graduation Requirements & College Entrance*

G. *Other*

IV. *Participants' Background Information*

A. *Follow-Up Information*

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