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Editor's Note

Joe W. Kotrlik
Louisiana State University

As this issue goes to press, the debate has started about the Bush Administration's proposed Carl D. Perkins Secondary and Technical Education Excellence Act of 2004. The proposal, entitled "A Blueprint for Preparing America's Future: The Carl D. Perkins Secondary and Technical Education Excellence Act of 2004," builds on the No Child Left Behind Act and is expected to address how states and partnerships among local educational agencies, postsecondary educational institutions, and others develop and support career and technical education pathways that prepare youth and career-changing adults for the future. A copy of the proposal can be viewed at: http://www.ed.gov/policy/sectech/leg/cte/04blueprnt.doc and a summary can be found at: http://www.ed.gov/policy/sectech/leg/cte/04summ.doc. Many of our AVERA leaders and members will be involved in the debate surrounding this legislation.

Given the discussion and debate about the new legislation, it is interesting that the first article in this issue by Richard Zinser and Frances Lawrenz addresses how an Advanced Technology Education (ATE) Program can serve as a model for business and industry collaboration for producing more and better technicians. The new roles of industry and college leaders are discussed through a synthesis of literature on skill standards and workforce development and data demonstrating substantial goal attainment are presented from a national evaluation of ATE projects on collaboration, materials development, professional development, and program improvement. The authors conclude the paper with a discussion on how this process has changed and benefited partnerships.

The second article co-authored by Scott Johnson, Angela Benson, John Duncan, Olga N. Shinkareva, Gail Diane Taylor, and Tod Treat addresses another issue directly related to the proposed new legislation, Internet-based learning in postsecondary career and technical education. This article presents the results of a national study of distance learning in postsecondary career and technical education (CTE). The results show that community colleges are actively involved in the delivery of CTE via distance learning and that Internet-based courses are the most prominent form of distance learning in community college CTE programs, especially for credit courses. Some colleges are creating their own online programs while others are partnering with other providers to make CTE courses available to students.

The article by Paul Brauchle and Md. Shafiqul Azam, "Factorial Invariance of the Occupational Work Ethic Inventory (OWEI)," reports a study that compared the factor structures of the Occupational Work Ethic Inventory (OWEI) for self-perceived work attitudes of manufacturing employees and their supervisors' ratings of those same employees. The study evaluated the construct validity of the instrument through comparative factor analysis. The authors concluded that the factors of OWEI are replicable in different populations and that evidence exists for the construct validity of this instrument.

This issue concludes with the study by Kurt Becker and Somchai Maunsaiyat in which they compared student attitudes and achievement in constructivist and traditional classroom environments in vocational electronics programs in Thailand. They found that although no differences exist for constructivist instruction over traditional instruction, the students still preferred the constructivist approach by a 4 to 1 ratio. Students had a positive attitude toward the constructivist process in the classroom, and toward their teacher's role. Moreover, the results of this study show that in this setting, constructivist instruction is at least as good as the traditional approach.

The authors are commended for conducting the research reported in these articles. Each of these studies represents a quality contribution to our body of knowledge in career and technical education.

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New Roles to Meet Industry Needs: A Look at the Advanced Technological Education Program

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Abstract

The Advanced Technological Education (ATE) program, sponsored by the National Science Foundation, is presented as a model for business and education collaboration to develop technical degree programs for producing more and better technicians. The new roles of industry and college leaders are discussed through a synthesis of literature on skill standards and workforce development. Data are presented from a national evaluation of ATE projects on collaboration, materials development, professional development, and program improvement that demonstrate substantial goal attainment. A discussion on how this process has changed and benefited the partnerships concludes the paper.

Introduction

The purpose of this paper is to examine the hypothesis that the ATE program is effective in meeting emerging needs of community college technician education. The theoretical, explanatory framework is that the effectiveness of the ATE program is due to its positioning at the juncture of two major trends in technician education and to its comprehensive approach. The research literature is synthesized in order to establish the existence of the two major trends—the need for technicians by industry and the changing role of community colleges. The ATE program is then shown as a catalyst which allows these two trends to interact constructively through the ATE program components of collaboration, materials development, professional development, and program improvement.

The Advanced Technological Education (ATE) program sponsored by the National Science Foundation is the pinnacle of collaboration between industry and education. Begun in 1993, the ATE program provides about $38 million in funding to various institutions or consortia across the country to improve technological education in strategic, advanced technology fields such as telecommunications or biotechnology. The program is a direct and effective response to the challenge of providing trained employees for high-tech, high-demand, high-wage jobs. In a broader context, the program may be seen as making a significant contribution to the workforce development system.

Background

The Need for Technicians

There are several dimensions to the surfacing of the need for more and better technicians: the designation as a national priority, the growth of technician-level positions requiring an associate's degree, and the implementation of industry-based skill standards**.** First, numerous publications in the last decade have outlined how advanced technology, the global economy, and changing demographics have created the need for education and training programs to supply industry with qualified technicians. The US national need for more technicians was anticipated in the early 1990s in reports such as *Gaining the competitive edge: Critical issues in science and engineering technician education* (National Science Foundation,1993) and *Technology for all Americans: A rationale and structure for the study of technology* (International Technology Education Association, 1996). Some industries are experiencing a wave of employee retirements, while at the same time new technology is requiring additional training for companies to remain internationally competitive. The training is so extensive and applied to so many personnel that human resource development professionals are looking to outside contractors (e.g. community colleges) to help develop and provide programs. Occupational and technical programs offered at community colleges are especially important in today's rapidly changing job market. When asked about the economy, community college administrators mentioned several of their programs as particularly relevant to national economic recovery: digital systems, facilities technology, manufacturing process technology, and telecommunications (Coley, 2000).

Yet many young people may not be aware of the opportunity and the potential of technician level jobs because of a bias for the four-year college degree. As discussed by Grubb (1999a), the occupations with the highest growth rates require less than a bachelor's degree, typically one to two years of postsecondary technical education. This training increases the probability that students/employees will receive better pay and advancement opportunities in technical positions than those with industry experience only, and in some cases even better than those with a bachelor's degree. In order to entice students to consider a technical career companies have had to form alliances with others in the same or similar industry to promote the benefits of their technician jobs in schools and colleges.

Another aspect in the growth of technician-level jobs is the advancement of national, industry-based skill standards. The standards are typically developed by a group of companies within an industry to define broad job categories and to establish entry level and career advancement criteria. The study by Bunn and Stewart (1998) with committee members for technical programs showed that the use of standards increases communication between industry and education because the standards provide a basis for curriculum and assessment. Having an international benchmark also increases the accountability of programs to meet industry's needs.

In the last few years, the National Skill Standards Board has been encouraging business and industry to communicate their requirements and work together. Edie West (2001), then Executive Director of the Board, concluded that "a system of skill standards, assessment, and certification that identifies what a worker needs to know to perform his or her job may well hold the answer …" (p. 11) to meeting the workforce development challenge. Since community colleges have always worked (more or less) with industry, they may be in the best position to deliver these skills.

Zeiss (1999) described the use of standards to certify skills as "a major opportunity for community colleges" (p.14). In some cases a college degree has become less meaningful in the work world because although it indicates acquisition of technical and academic knowledge, it may not provide evidence of skills. A professionally recognized skill certification on the other hand verifies and documents that the completer has attained the prescribed skill levels. It also supplies a target for continuous education to keep incumbent employees' skills updated. Zeiss envisions a training and verification system that is the equivalent of the International Standards Organization for the development of technical skills. Programs are state-of-the-art because of industry involvement and continuous review. This also establishes credibility with both companies and students (Cantor, 2000) because the required competencies are certified, in some cases by a third-party examination. The resulting credential is then visible, recognized by the profession and portable for the student-employee across company or geographic boundaries (Wonacott, 2003).

Changing Role of Community Colleges

Evidence of how the role of community colleges is changing can be seen in the needs analyses being conducted, the transition to a market orientation, the growing diversity of non-traditional students, and the merging of training and education programs. To begin with, although technical education is provided through a variety of venues, a critical recent focal point is community colleges. Community colleges can play a unique role in validating and providing skills but they are faced with the need to continue to expand both academic and vocational offerings (Carnevale & Desrocher, 2001). Furthermore they are in competition with the rapidly growing number of certifications offered by national industry, trade and professional associations and company vendors, such as Microsoft, Cisco, and others (National Organization for Competency Assurance, 2000).

Are community colleges prepared to fulfill the needs of technical workforce development? Hamm and Mundhenk (1995) examined this question systematically to determine colleges' readiness for the new demands being placed on them. In their analysis for the National Council for Occupational Education, the authors put forth 19 questions designed to elicit discussion on institutional mission, funding, staffing, delivery systems, and the like. In the context of technician training, important questions are: How effectively does the college assess local labor market needs?

How well do degree requirements match industry standards? Does the college measure its impact on the economic development of the community? The development of a new technician program (e.g. a new associate's degree for chemical process technology) may compel community colleges to reassess their roles because the new program often requires assessing and marshalling resources under new priorities. McCabe (1997) described the community college as the "nexus for workforce development" because of their proximity, access, flexibility, cost effectiveness, and experience working with industry.

According to Walter and Farmer (1999), ". . . the traditional practices of begging for resources and inviting representatives to serve on ineffective advisory groups have only served to alienate business and industry" (p.177). The new technician programs, based on demanding standards and quick turnaround time, do not always fit well with conventional college practices. Instead, industry first identifies the skills and performance measures, and then helps develop and sometimes teach the courses. "These employers simply do not trust [that] traditional, faculty-developed curriculum will meet their needs" (Jacobs, 2001, p. 8). What Jacobs calls the "new vocationalism" is the technician programs based on specific technological processes. Relevance of the programs is defined in terms of the ability to meet an external standard for occupational achievement.

Is this market orientation a new role for community colleges, or should it be? The debate on the changing role was summarized recently by Bailey (2003) for the Community College Research Center. Community colleges have always been comprehensive institutions that serve many needs, including remedial and transfer programs. Workforce development also covers many things such as welfare-to-work programs, part-time training for new job entrants, and upgrades for existing employees--sometimes through coursework and sometimes through non-credit contract training.

In addition to facing a different market for their area, community colleges are faced with very different students than they have been used to in the past. The new technician degrees require a specific occupational focus for a student population that is changing dramatically. According to research by the Business Coalition for Education Reform (2002), the "typical" community college student is now 29 years old; 60% attend part-time; 80% work and attend school; 50% already have a postsecondary credential; and 28% already have a Bachelor's degree. So as community colleges adapt they will likely maintain their comprehensive mission but somehow have a dual focus on learner needs and employer expectations.

In his examination of postsecondary vocational education, Grubb (2001) described an emerging system of workforce development that bridges short-term training and mainstream education. Some workforce programs in the past have been ineffective due to waste and duplication, low quality instruction, and the lack of information and tracking of participants' progress. But by targeting the high potential employment opportunities, such as the technician positions, colleges can bring to bear the resources provided by both business and the institution. Orr (2001) echoed this point by stating that programs should focus on growth industries and increase collaboration with businesses and other colleges. In so doing, programs can share expertise and resources, costs and risks.

The new system therefore emulates the design and execution of a product stream in business, following the same principles of Total Quality Control (Zeiss, 2000). Working with community colleges, consortia of companies are beginning to develop and manage a knowledge supply chain to ensure a pipeline of qualified technicians. The community colleges can become one of the "preferred suppliers" for these industries.

Methodology

The data presented here were collected as part of a comprehensive evaluation of the national ATE program by Western Michigan University's Evaluation Center. As part of this evaluation, a yearly Web-based survey is administered to all current ATE projects that have been in operation for one year. In addition to the survey, a subset of 13 local sites was selected for in-depth site visits.

The Web-based survey has been conducted every spring since 2000. The survey consists of four sections addressing the work categories of the ATE Program: collaboration, materials development, professional development, program improvement. Program improvement includes items about recruitment and retention as well as descriptive information about the programs. Three additional sections are devoted to basic information (i.e. demographics), monitoring, and status of the projects. The response rates each year are quite high—in the 90% or above range. In 2000, 100 projects responded; in 2001, 75; in 2002, 77; and in 2003, 128. The survey items and results are posted at http://www.wmich.edu/evalctr/ate/.

Site visits were made to 13 ATE sites (3 centers and 10 projects) to provide in-depth data to illuminate the survey data. Judicious mixes of knowledgeable evaluators and content experts conducted the visits. Sites were selected using a purposive sampling technique based on recommendations from NSF, thus ensuring a cross section of types in the ATE program**.** Sites were primarily selected based on maturity (time conducting the project), technological disciplines, funding levels, geographic dispersion across the US, major ATE objectives the projects addressed, and type of sponsoring organization. Specifically six projects were in their second or third year of funding, and seven projects were in at least their fourth year of funding. The technological disciplines represented were: Chemistry/Environmental (3), Manufacturing Technology (3), Information Technology (3), GIS/Multimedia (2), Engineering Technology (1), and Biotechnology (1). Seven projects were funded for a total of $750,000 or less, while six projects received a total of more than $750,000. Of the 13 projects, four were located on the west coast, four in the middle section of the US, and five on the east coast.

To minimize the burden on the organizations, site visits were usually one full day in length for projects and two full days for centers. Activities included interviews with key personnel (e.g., principal investigators, co-principal investigators, business and industry collaborators, faculty, students), review of materials (e.g., modules), tours of facilities (e.g., labs), and observation of activities (e.g., classes). Reports were shared with the sites to verify the accuracy and perceptions of the site visitors.

The survey results and the site visit reports served as data for the following sections describing the four work areas of the ATE program: collaboration, materials development, professional development, and program improvement.

Program Data

The ATE Program

The ATE projects exemplify the successful implementation of new technician programs to help fulfill the needs of industry, while helping community colleges meet the demands of their new role. The various technologies and geographic regions addressed by ATE projects show that the model can work in remarkably diverse situations. For example, there are new associate degrees in Information Technology, Manufacturing Technology, Marine Technology, Chemical Process Technology, Environmental Technology, and Bio-Technology, just to name a few. Although the specific projects focus on certain technologies or industries, most of them are developed through a similar process based on the following major components, or drivers.

Collaboration

Obviously colleges and businesses have been collaborating to some extent all along, but ATE projects are expected to have a higher level of collaboration, to formalize and evaluate the partnerships (Reed, 2001a). For example, a group of industry representatives will review and help revise the technician curriculum, be involved in pilot and field-testing the program, and finally, provide verification that it is producing the outcome of developing qualified technicians. Because industry has been involved in the development process, the credibility of the program increases; the businesses are more likely to hire the graduates, and students who enroll in the program can be confident of its relevance. Articulation between institutions and the dissemination of curriculum materials is also greatly improved.

The most recent report by the Evaluation Center (Hanssen, Gullickson, & Lawrenz, 2003) shows that 87% of the projects (*n* = 128) were engaged in substantial collaborations. As noted in Table 1, the data are also divided into four sectors: 81% had collaborations with business and industry, 68% with public agencies, 84% with educational institutions, and 47% with other organizations. The highest level of collaboration was in the general support category which includes advisory committees and curriculum development; monetary and in-kind contributions amounted to almost $21 million for the 97 projects reporting. The projects also rated the quality of their collaborations as “good” to “excellent”.

Table 1
Collaborations on Advanced Technology Education (ATE) Projects Between Community Colleges and External Institutions

Type of Institution	*n*	%
Business & industry	90	81.1
Public agencies	75	67.6
Educational	93	83.8
Other	52	46.8
Total	111	86.8

Note. Categories are not mutually exclusive

The development of materials for ATE projects generally includes new courses or new modules which are self-contained units that may be applied in more than one course**.** The NSF grantees are encouraged to use a developmental framework, outlined by Rogers (2001), to ensure that high quality materials are produced. Materials should:

- reflect the results of a formal needs analysis,
- be industry verified,
- reflect learning goals and objectives,
- be developed/adapted as part of a systematic curriculum development process,
- support and identify instructional strategies including pedagogy and assessment,
- undergo pilot and field testing,
- be continuously evaluated, and
- be revised based on evaluation evidence (p.7).

Survey data reveal that 77% of the projects were engaged in materials development, resulting in 266 different products (Table 2). As for the development process, the projects reported that they used industry-based standards to guide materials development “most times” or “each time”. Materials were also pilot tested and field tested most or each time, and the standards were used in assessing student success in the courses.

In order to implement new instruction effectively, project faculty must update their skills and be trained to teach in the new program. As summarized by Gold and

Powe (2001), there are seven basic elements that contribute to successful training programs:

- ongoing learning and training,
- institutional support,
- hands-on and classroom-based experiences,
- individualized training,
- follow-up training,
- mentoring, and
- train-the-trainers approach to continuing education.

Table 2
Numbers and Stages of Materials Development

Development Stages	Courses *m*	Courses *n*	Modules *m*	Modules *n*
Draft stage	3.2	45	8.0	42
Being field-tested	3.7	31	6.9	36
Completed	7.7	43	7.9	38
In use locally	6.8	48	8.1	36
In use elsewhere	4.5	10	26.8	25

The authors found that "the more of the 7 elements an ATE site employs, the more likely it is that desired outcomes would be achieved" (p.4). One of the more important findings is that, in many cases, the professional development received by project faculty would not have been possible except for the NSF funding.

The 2003 survey data show (Table 3) that 104 of the projects (81%) reported offering 1,104 professional development opportunities that were attended by 14,709 faculty and staff. Conferences, workshops, and in-services were the most common development activities; in addition, 48 faculty participated in industry internships, and 226 participated in online courses. Most of the projects conducted some kind of follow-up with the participants, mostly through letters or e-mails, personal contact, survey, or newsletter. Implementation strategies were also studied, showing that most participants were satisfied with the activities and intended to use the materials; about half the participants were able to try the technology or materials in the classroom, and incorporate the materials directly into the program.

Program improvement refers to the integrated efforts of the entire process, from needs assessment to sustainability, and focuses on fine-tuning the elements to increase the impact of the program. Some of the elements identified by Reed (2001b) are:

- a curriculum development and implementation process;
- an organized sequence of classes, laboratories, and work-based experiences;

- emphasis on STEM standards (Science, Technology, Engineering, and Mathematics), communication skills, critical thinking, advanced technology courses, and workplace competencies;
- leads to an appropriate degree, certificate, or occupational completion point;
- provides industry with an increased pool of advanced technicians; and
- structured to obtain maximum articulation of educational experiences.

Table 3
Professional Development Opportunities and Participants

Development	Opportunities		Participants	
	m	*n*	*m*	*n*
Conferences	2.6	166	69.0	4214
Workshops	3.7	325	62.5	5317
In-Services	3.9	253	42.8	2568
Internships	0.8	36	1.2	48
On-Line Courses	2.9	128	6.1	226
Other	7.5	196	93.4	2336
TOTAL		1104		14709

Although Reed found that there was room for improvement in several areas—such as formally involving industry in the field-testing of new courses—the 2003 survey data demonstrate considerable success in terms of program improvement (Table 4). First, there were 4,381 courses offered for ATE funded projects, with 68,450 students taking at least one course in the last 12 months; 88% of the courses were taken at community colleges, with 6% each in secondary and baccalaureate institutions. In addition, 30% of the courses for specified ATE projects were new and 24% were changed or updated. Second, projects reported significant changes in the classroom environment due to ATE program efforts: 46% increased the use of work-based skills in curricula, 44 % reported increased interest by students, 55% had more relevant and up-to-date materials, and 49% showed a movement away from traditional lecture delivery. Third, articulation agreements are increasing that improve the transition of students between educational levels, which may increase the number of students choosing the technician programs. Articulation between secondary and two-year colleges was reported by 34% of projects, while 41% have agreements between two-year and four-year colleges.

Discussion and Implications

The collaboration of industry and education is an evolving relationship, but it has been catalyzed recently by the infusion of the ATE projects in emerging technology fields. This could be viewed as the point at which two trends are merging: the need for new technicians and the new market orientation of community colleges. The urgency felt by many industries for the development of a new system to supply their technician needs has forced them to seek partnerships with community colleges and to take a more long-term, strategic view of the relationship. Meanwhile the colleges have had to be more open to the involvement of industry experts, to streamline their curriculum development process, and to seek out professional development opportunities. Both parties have the same goal to educate and employ new technicians, and since the problem has become too big and too complex for any one organization, the best solution may be to collaborate.

Table 4
Program Improvement Indicators

Indicators	Measure	Categories
Courses:	Classes Offered	4,381
	Students	68,450
Classroom changes:	Work Skills	46%
	Increased Interest	44%
	Increased Relevance	55%
	Less Lecture	49%
Articulation:	Secondary/Associate	34%
	Associate/Bachelor	41%

In their report on critical issues for the National Coalition of Advanced Technology Centers, Anderson and Kosarek (1997) recommended that technician training must be done by qualified faculty with relevant work experience and must be done on equipment actually used by industry. Additionally, some of the training may have to be conducted on site and with a flexible schedule to meet industry needs. In this role the community college serves as another certified supplier for the company, and ideally may be seen as an extended department of the company.

This is exactly what the ATE projects aim to do. For example, one of the better known partnerships is the Gulf Coast Process Technology Alliance started in 1995 with 60 petrochemical and refining facilities, and 23 community and technical colleges in 10 states (Hayes, Kiles & Raley, 2001). A grant from the National Science Foundation allowed them to form the Center for Advancement of Process Technology at the College of the Mainland in Texas. Working with industry experts, the Center created eight new courses for the AAS Degree in Process Technology. The courses were also designed for web-based delivery to upgrade the skills of current technicians. Some companies help build the technology labs for their local community colleges, and the colleges hire part-time or retired employees from the companies as instructors. Most importantly, the companies hire the graduates from the new program with advanced employment standing, saving substantial time and money (American Association of Community Colleges, 2003).

This is a new and challenging role for many community colleges. Grubb and his co-authors (Grubb, Badway, Bell, Bragg, & Russman, 1997) described the emergence of the "entrepreneurial college"—a college within the regular college—that focuses on workforce, economic, and community development. In the role of workforce development the college responds to specific employers with customized training or contract education; employers help design the curriculum, assessment, and scheduling. In economic development, the aim is to help the general economy of the area by convening industry clusters, helping with technology transfer, fostering business leadership, scanning economic environment, policy-making, attracting employers to the region, and media and telecommunications. Finally, community development is meant to promote the well-being of the immediate community through political, social, and cultural areas efforts. All of these activities performed in development roles will contribute to the collaboration—and vice versa—with local industry groups.

The entrepreneurial college requires different measures of success, not just enrollments and credentials completed. Instead, the "college" is moving towards measuring employer satisfaction, the wages of completers, and the number of repeat customers. (Ideally, the college should follow program completers to see if they are more productive on the job, are employed longer, and are promoted more frequently, but there is little research in this area). The benefits of this business-like relationship are additional students, increased revenues, and the confidence that the college is keeping up with skill requirements. These new roles are moving the community college "… from an institution focused on educating students to one centered on meeting the needs of business and the local community" (Dougherty & Bakia, 1999, p. 1).

The "new college" is also much more visible and publicly supported. In Brand's (1997) report to the National Coalition of Advanced Technology Centers she noted that community college presidents are increasingly giving their mission statements to local business groups and boards of trustees for review and input. Colleges are also working more vigorously with state and local economic development agencies, state legislators, associations, and universities. All of this publicity and focus on business may lead to tensions with the traditional part of the institution. However, the new technician degrees might be seen as a hybrid of the credit programs and workforce development (because they are responsive to industry but also culminate in a degree that is transferable to a four-year college) which may serve to reunite the two "colleges".

The ATE projects would also seem to fulfill Grubb's (1999b) five criteria for judging the effectiveness of vocational education. First, effective programs "… understand the local labor market, and target those jobs that are likely to employ individuals with community college credentials, with relatively high earnings, strong employment growth, and opportunities for individual advancement" (pp. 8-9), all of which are met by the technician programs which are the focus of this paper. Second, effective programs ". . . contain an appropriate mix of academic education, occupational skills, and work-based learning . . . " (p. 9), again which are designed into the technician programs. The other three criteria deal with the institutional aspects of support services, further education, and information on results.

Conclusion

The ATE program is the pinnacle of collaboration between industry and education. Through its emphasis on formal collaboration, materials development, professional development, and program improvement, the ATE program has made significant accomplishments toward the goal of providing the nation with more and better-trained technicians. Studying the examples provided by ATE projects, which are listed on the NSF website, can help other businesses and community colleges move forward. (See also Mahoney & Barnett, 2003, *The Learning Edge: Advanced Technological Education Programs at Community Colleges*). Evaluation of the actual impact—the numbers of new and updated technicians being employed—is an ongoing project, but the indicators look very positive

The process used by the business-education partnerships may be replicated in other industries and local communities. Typically consortia of companies target a technician level need and proceed to work with one or more community colleges to develop a new technical degree. Following the guidelines discussed above in the four components of successful programs, the partners work out the roles and responsibilities, funding and timing. They collaborate to produce new curriculum starting with a competency profile, task list, or skill standards; the materials are tested, verified, and continuously evaluated; faculty are provided with various forms of professional development; and the program is marketed, articulated, and sustained.

ATE projects have overcome many of the barriers that can frustrate business-education partnerships (Lawrenz & Zinser, personal interviews, February-August, 2003). Business leaders are sometimes perceived as being interested in quick fixes to their problems, and therefore try to muscle their suppliers into coming up with a solution. Colleges on the other hand can be seen as bureaucratic and slow to change. But the national need for a high-tech workforce has brought the two sectors together and inspired them to collaborate on a long-term, yet entrepreneurial basis.

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Internet-Based Learning in Postsecondary Career and Technical Education

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Abstract

This article presents the results of a national study of distance learning in postsecondary career and technical education (CTE). The main purpose of this study was to identify the current status and future trends associated with distance learning in postsecondary CTE. The results show that community colleges are actively involved in the delivery of CTE via distance learning. Internet-based courses are the most prominent form of distance learning in community college CTE programs, especially for credit courses. While some colleges are creating their own online programs, many are partnering with external providers (e.g., commercial vendors) and other colleges and universities to make credit and noncredit CTE courses available to students. It was noted that the community colleges are relying heavily on low-bandwidth technologies, although significant growth in all forms of Internet-based CTE courses and technologies is expected within the next three years.

Introduction

The Internet and web-based computer technologies that support online learning have changed the education landscape considerably. Internet technologies now provide easy to use, powerful, and economically sound media for educational purposes. As a result, large numbers of public higher education institutions are offering courses online and they expect growth in this type of education in the near future (Allen & Seaman, 2003). According to the same source, the majority of public higher education institutions indicated that online courses attract growing number of students when compared to traditional education, and achieve the same or even higher learning outcomes. Also, faculty involvement and acceptance of online education is increasing. This growth has come, in part, because of the increase in access to computers, broadband Internet, and software packages, such as course management software, that are designed to make Internet-based learning more user-friendly (Phipps & Merisotis, 2000). In addition, the changing demographics of college students support the need of a flexible postsecondary educational delivery system. Students today are older, employed, married and/or have dependents; this creates a need for flexibility of course delivery, both in terms of time and place (National Center for Education Statistics [NCES], 2000). Finally, traditional students (i.e., those entering higher education immediately following high school) are Internet-literate and have come to expect a high level of technology use in their coursework, making them more receptive to Internet-based courses (Synergy Plus, 2002).

The growth of Internet-based courses has been accompanied by the development of benchmarks of quality based on best practices in institutional support, course structure, instructor student interactions and support, and assessment (Phipps & Merisotis, 2000). In addition, numerous studies have found no significant differences in learning outcomes or student satisfaction between traditional courses and Internet-based courses. Criticisms of these comparison studies have focused on the lack of theoretical frameworks, rigorous controls, or researcher objectivity. However, rather than discrediting the "no significant difference phenomenon," these criticisms have led to the understanding that "it is irrelevant to speak of the effects of using the Web without understanding how it is entwined with instructional design and especially faculty choices about instructional design" (Meyer, 2002, p. 19).

Career and technical education (CTE) means many things to many people. To some people, it refers to a single course that provides specific skill training for job employment or advancement, while to others, it refers to a lifelong learning pathway that is used to obtain, update, and extend the knowledge, skills, and attitudes required to pursue a career successfully. Career and technical education imparts both specific occupational skills to those students wishing to enter employment directly and the academic skills they need for advancement and further postsecondary education (NCES, 2000).

According to the Association for Career and Technical Education (2003), CTE ". . . is about helping students, workers and lifelong learners of all ages fulfill their working potential" (p. 1). Although community colleges are known for providing high school and college students with relevant application of academic subject matter, employability skills, and career education, it also provides second-chance education and training for the unemployed and those seeking to upgrade their employability skills as well as professional development for career advancement through corporate training and continuing education. While CTE continues to be offered at the high school level, a more significant role is now being played by community colleges, technical institutes, and private, for-profit organizations. CTE programs offered by community colleges include health professions, office careers, computer science, agriculture, construction, and automotive A.A.S. degrees and certificates.

Community colleges have played a key role in connecting high school tech prep, industry training, and baccalaureate education[1] As an institution of higher education known for its adaptability and willingness to provide customized training, the community college has been influenced by industry (Dougherty & Bakia, 1999; Grubb, 1996) and federal policy, such as the Workforce Investment Act (WIA) and the Carl D. Perkins Vocational and Technical Education Act. Federal policy has generally acted to increase the workforce preparation role played by the community college. In fact, community colleges are becoming the designated provider of customized training in many states (Villadsen & Gennett, 1997).

Community colleges have not only played a major role in the delivery of CTE courses, but have also rapidly expanded their Internet-based programs (NCES, 2000; Reese, 2002). The number of nontraditional postsecondary CTE programs offered through distance learning is increasing — "a trend that should benefit both the students and the workplace of tomorrow" (Reese, 2002, p. 24). Lever-Duffy, Lemke, and Johnson (1996) compiled examples of model community college distance learning programs and concluded that distance learning, while "once a fringe methodology, is fast becoming a fundamental methodology for the Information Age institution" (p. vii). In a 3-year trend study of the 700 member colleges of the League for Innovation in the Community College, Milliron and Miles (2000) identified expected trends for instructional technologies and distance learning in community colleges. Most of the participating schools agreed that the trend towards the use of information technology in instruction would increase over the next 3 to 5 years while fewer than 15% expected that the trend towards distance learning would decrease. According to the Campus Computing Survey, 74% of community colleges now offer online courses to students (Green, 2000). In the early stages however, courses were developed that were oriented to the delivery of general education, liberal arts, and business and management courses (Synergy Plus, 2002). Colleges now offer online technical and vocational courses to students as well.

Statement of the Problem

As community colleges expand their role as a CTE provider, they are exploring the potential of distance learning through Internet-based CTE courses and programs. Internet-based CTE courses and programs, however, provide a particular challenge because of the need to develop skills at a distance. As with any new area of emphasis in education, there is limited understanding of the scope of distance learning in CTE and its impact on distance learning on postsecondary CTE. Hence,

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[1] For the sake of brevity, the term "community college" will be used generically to include not only community colleges, but also technical institutes and junior colleges.

the primary purpose of this study was to determine the current status and future trends associated with Internet-based learning in postsecondary CTE. The study was designed to address the full breath of postsecondary CTE rather than a specific subset of the field. To accomplish this purpose, a national study was conducted to answer the following research questions:

1. How prominent is Internet-based learning in postsecondary CTE?
2. What strategies do community colleges use to provide and coordinate Internet-based CTE?
3. What types of technologies are used to deliver postsecondary Internet-based CTE courses and what technologies are expected to be used in the future?

Method

This study involved a descriptive analysis of the status of Internet-based learning in postsecondary CTE programs. A nationally representative sample of community colleges was asked to participate in the research to answer questions addressing the prevalence of Internet-based learning in postsecondary CTE.

Participants

The target population for this study was defined as postsecondary colleges and technical institutes that are members of the American Association of Community Colleges (AACC). The sampling frame containing 1,015 member institutions was obtained from AACC. This list provided a national representation of institutions, and included all types, sizes, geographic locations, and settings (i.e., urban, suburban or large town, rural).

Based on discussions with AACC researchers, it was determined that their membership, in terms of institutional characteristics, was heterogeneous across states and homogenous within states. Therefore, a proportionally representative sample was obtained using a stratified random sampling technique. A total of 552 member institutions were randomly selected from the AACC membership database with the number selected proportional to the number of community colleges in each state.

Instrumentation

The development of the questionnaire for this study involved working closely with contacts at several professional associations that are closely connected to community college research, including studies of distance learning. The associations were contacted to gain insight into related studies they have completed, to seek their advice on increasing response rates, and to identify the critical questions that needed to be included in the questionnaire. In addition to involving these professional associations in the development and validation of the questionnaire, the instrument was pilot-tested with two community college leaders whose institutions were not included in the national sample. Only minor changes were in the questionnaire were suggested.

The questionnaire employed the definition of distance learning used by the National Center for Education Statistics in their studies of distance learning in postsecondary education institutions (NCES, 2000, 2003). This definition highlighted education or training courses that are delivered to off-campus locations using both synchronous and asynchronous delivery modes of instruction. As with the NCES surveys, courses offered exclusively on-campus, those offered via written correspondence, and those where the instructor travels to a remote site to deliver instruction in person were not included in this definition of distance courses. Data from all CTE courses and programs at the institution were to be included in the responses.

The questionnaire contained 14 items that asked for specific data regarding courses, programs, enrollments, and technologies used in distance CTE. The estimated amount of time needed to complete the questionnaire was 1–2 hours. The anticipated length of the questionnaire and projections of respondent burden were determined based on estimates used by NCES in their national study of postsecondary institutions (NCES, 2002).

Data Collection Procedures

This study involved mailing a questionnaire to the executive officers of each of the postsecondary institutions identified in the sample. A four-round data collection process was used to obtain responses to the survey that included sending questionnaires to the institutions in the sample and using several follow up techniques to increase the response rate.

The procedure used for response rate calculation was based on the guidelines established by the Council of American Survey Research Organizations (CASRO) and used by the American Association for Public Opinion Research (2000). Forty entries were removed from the originally selected sample because of incomplete contact information, leaving an accessible sample of 512. Using the CASRO RR_2 formula, a final response rate of 53.3% was achieved, which compared quite favorably with a study conducted by AACC. AACC obtained a 19% response rate for their study that involved chief academic officers at more than 1,100 community colleges, and 205 colleges responded (Nock & Shults, 2001).

An important consideration in survey research is the degree to which the survey respondents are representative of the target population. To verify the representativeness of the respondents to the population, several statistical comparisons were performed, including demographic comparisons, respondent versus non-respondent comparisons, and early versus late respondent comparisons.

Because no apparent differences were found between the groups, one may conclude that the respondents are representative of the nonrespondents within the sample and the target population in general. Overall, the useable responses represent 26.6% of the target population.

Data Coding and Analysis

The current status of Internet-based CTE was determined by describing the characteristics of a nationally representative sample of community colleges at one point in time. In accordance with the research questions, the examined variables reflect the extent of colleges' participation in Internet-based CTE, types of courses offered, technologies used, and future trends in technology usage.

The current status and future trends of CTE distance learning was determined by measuring the characteristics of the nationally representative sample of community colleges at one point in time. Pre-specified variables and several types of groupings were used (i.e., urban, suburban or large town, and rural; East, Midwest, West) to organize the data and to calculate frequencies and trends associated with Internet-based CTE. Groupings were based on the categorizations used by AACC. Version 11 of SPSS was used to complete the analysis.

Results

Institutional Participation in Distance CTE

Overall, the majority of community colleges provide some form of CTE courses and programs through distance learning. Of the responding community colleges, 76.3% offered CTE courses via distance learning in 2001–2002 (Table 1). CTE distance learning courses were more likely to be offered by community colleges in urban (82.8%) and suburban/large towns (80.5%) than in rural (66.3%) areas. Large community colleges were also more likely to offer CTE via distance learning than were small community colleges. About 82% of the colleges with 3,001–10,000 students, which represents 42% of the respondents, offered CTE courses via distance learning. In comparison, 70% of the colleges with 1,001–3,000 students and about 52% of the colleges with fewer than 1,000 students offered CTE courses via distance learning. No substantial differences in offering CTE courses via distance learning were found among the responding community colleges located in East, Midwest, and West regions of the country.

Internet-Based Courses and Programs in Postsecondary CTE

The community colleges that offered CTE distance learning courses were asked to report the number of credit and noncredit Internet-based CTE courses. Table 2 shows that an average of 36 Internet-based CTE courses are offered for

Table 1
Distribution of Community Colleges Offering CTE Courses

Institutional Characteristic	*N*	Institutions Offering Distance CTE (%)	Institutions Not Offering Distance CTE (%)
All respondents	270	76.3	23.7
Regions			
East	114	76.3	23.7
Midwest	81	76.5	23.5
West	75	76.0	24.0
Institution Locale			
Urban	93	82.8	17.2
Suburban or Large Town	82	80.5	19.5
Rural	95	66.3	33.7
Institution Size			
1,000 or fewer	23	52.2	47.8
1,001–3,000	90	70.0	30.0
3,001–10,000	114	81.6	18.4
More than 10,000	43	88.4	11.6

Note. Percentages are computed within each classification variable; *n* represents the actual number of responding institutions.

Table 2
Average Number of Internet-Based CTE Courses

	Internet-Based CTE CTE Credit Courses		Internet-Based CTE Noncredit Courses	
Institutional Characteristic	*n*	*M*	*n*	*M*
All Institutions	185	36.0	150	67.0
Region				
East	76	32.2	62	25.5
Midwest	57	41.4	47	57.5
West	52	35.5	41	13.5
Institution Locale				
Urban	69	47.6	61	25.6
Suburban or Large Town	58	33.9	44	57.8
Rural	58	24.0	45	16.9
Institution Size				
1,000 or fewer	11	12.6	9	15.3
1,001–3,000	60	35.9	43	41.6
3,001–10,000	79	32.2	69	14.6
More than 10,000	35	51.6	29	65.7

Note. Of the 206 responding institutions that offer distance CTE, 185 provided CTE credit enrollment numbers, and 151 provided CTE noncredit enrollments for Internet courses.

credit and 67 noncredit Internet-based CTE courses per academic year. The average number of Internet courses offered for credit was higher in urban colleges (47.6) than in community colleges located in suburban areas or large towns (33.9) and rural areas (24.0). The average number of noncredit courses for colleges located in suburban areas or large towns (57.8) was higher than for colleges located in urban (25.6) and rural areas (16.9). Overall, larger community colleges offered more credit and noncredit Internet-based courses.

Table 3 shows that, on average, community colleges offered 74.8% of their credit CTE courses and 46.6% of their noncredit distance CTE courses via the Internet. These credit and noncredit percentages remained fairly constant across locale. Although larger community colleges tend to offer more courses, there was no significant correlation between institution size and the percentage of credit (r = -.0046) and noncredit (r = -0.05) Internet-based CTE courses offered.

Table 3

Number and Percentage of Community College Distance CTE Courses Offered via Internet

	Internet-Based CTE Credit Courses		Internet-Based CTE Noncredit Courses	
Institutional Characteristic	*n*	%	*n*	%
All Institutions	131	74.8	77	46.6
Region				
East	61	70.6	33	58.1
Midwest	39	75.8	27	41.2
West	31	81.8	17	32.8
Institution Locale				
Urban	48	74.3	36	43.7
Suburban or Large Town	39	78.7	19	50.0
Rural	44	71.9	22	48.4
Institution Size				
1,000 or fewer	7	76.3	5	66.0
1,001–3,000	50	75.5	20	35.5
3,001–10,000	50	73.5	40	53.6
More than 10,000	24	74.9	12	33.4

Note. Of the 206 responding institutions that offer distance CTE, 131 provided the total number of distance and Internet CTE credit courses, and 77 provided the total number of distance and Internet CTE courses.

Table 4 shows the percentage distribution of community colleges offering credit and noncredit CTE courses via the Internet according to the total number of Internet-based courses offered. As a group, 95.1% of community colleges offer credit courses and 41.1% offer noncredit courses. Of the responding community colleges, 52.4% offered 1–25 Internet-based courses for credit, 22.2% offered 26–50, 20.5%

offered more than 50 courses, and 4.9% offered no credit CTE Internet courses. Similar numbers were reported for noncredit Internet-based courses. Of the responding colleges, 58.9% offered no noncredit Internet-based courses; while 21.9% offered 1–25 courses and only 19.2% reported offering more than 25 Internet-based courses.

Table 4

Percentage of Internet-Based CTE Credit and Noncredit Courses

Credit Internet Courses	*n*	None	1–25	26–50	51–100	>100
All Institutions	185	4.9	52.4	22.2	13.5	7.0
Region						
East	76	7.9	50.0	23.7	11.8	6.6
Midwest	57	1.8	54.4	21.1	17.5	5.3
West	52	3.8	53.8	21.2	11.5	9.6
Institution Locale						
Urban	69	5.8	42.0	23.2	18.8	10.1
Suburban or Large Town	58	3.4	46.6	29.3	15.5	5.2
Rural	58	5.2	70.7	13.8	5.2	5.2
Institution Size						
1,000 or fewer	11	0	81.8	18.2	0	0
1,001–3000	16	6.3	62.5	12.5	0	18.8
3,001–10,000	79	5.1	54.4	22.8	12.7	5.1
More than 10,000	35	2.9	28.6	25.7	28.6	14.3
Noncredit Internet Courses	***n***	**None**	**1–25**	**26–50**	**51–100**	**>100**
All Institutions	151	58.9	21.9	6.6	5.3	7.3
Region						
East	62	56.5	21.0	11.3	8.1	3.2
Midwest	47	51.1	31.9	4.3	0	12.8
West	42	71.4	11.9	2.4	7.1	7.1
Institution Locale						
Urban	61	63.9	18.0	3.3	6.6	8.2
Suburban or Large Town	45	55.6	20.0	11.1	2.2	11.1
Rural	45	55.6	28.9	6.7	6.7	2.2
Institution Size						
1,000 or fewer	9	44.4	33.3	11.1	11.1	0
1,001–3,000	9	66.7	11.1	0	0	22.2
3,001–10,000	69	56.5	27.5	5.8	7.2	2.9
More than 10,000	30	66.7	10.0	6.7	0	16.7

Note. Of the 206 responding institutions that offer distance CTE, 185 provided CTE credit enrollment numbers, and 151 provided CTE noncredit enrollments for Internet courses. Row percentages may not add to 100 due to rounding.

Strategies for Providing Internet-Based CTE

Community colleges were asked for the number of Internet-based CTE courses they offered through external providers or partnerships with colleges and universities. The term "partnership" connotes a sharing of resources for mutual benefit. Community colleges are uniquely positioned to partner with a wide variety of educational, professional, and commercial entities. The obvious focus of such partnerships is to provide enhanced learning opportunities, maximize use of costly infrastructure, and deliver courses to under-served populations. Partnerships typically include the community college and entities such as other community colleges, businesses, universities, regional organizations, professional organizations, technical suppliers, high schools, and publishers. One example of a community college partnership is the Illinois Virtual Campus (http://www.ivc.illinois.edu), which consists of 68 institutions delivering 3,500 courses in 115 programs while providing comprehensive support services at a lower cost. Another partnership example is the "Direct Path" program instituted by Rutgers University and three community colleges in order to improve transfer rates by providing increased access to online courses along with support for students and faculty.

Table 5 shows that the responding community colleges offered 16.2% of their Internet-based courses through external providers and 18.9% through external partnerships with colleges and universities. The external provider percentages were fairly consistent across institution locale, while rural colleges (23.2%) outpaced

Table 5

Percentage of Internet-Based CTE Courses Provided Through External Providers and Partnerships

	External Providers		College/University Partnerships	
Institutional Characteristic	*n*	(%)	*n*	(%)
All Institutions	172	16.2	185	18.9
Region				
East	71	17.6	77	20.3
Midwest	51	14.6	59	20.0
West	50	16.0	49	15.4
Institution Locale				
Urban	68	14.9	70	18.6
Suburban or Large Town	56	16.3	60	15.2
Rural	48	17.9	55	23.2
Institution Size				
1,000 or fewer	9	23.4	12	37.3
1,001–3,000	48	22.0	57	27.4
3,001–10,000	81	14.3	82	11.8
More than 10,000	34	10.8	34	15.2

urban (18.6%) and suburban (15.2%) colleges in college/university partnerships. Both external providers and partnerships were related to institution size. Smaller colleges (3,000 or fewer students) tended to provide a higher percentage of their Internet-based courses through external providers and partnerships than did larger colleges (more than 3,000 students). These data suggest that exciting new connections are being made as these participants in education find new ways of partnering to provide services for niche markets.

Table 6 shows the percentage distribution of community colleges providing Internet-based CTE through external providers and partnerships. Of the responding community colleges that offered CTE distance learning courses, 69.2% offered no Internet-based courses through external partnerships. The distributions were fairly similar across institution locale (urban, 70.6%; suburban, 67.9%; rural, 68.8%) for institutions that offer no Internet-based courses through external providers. Over half of the responding community colleges (53.5%) offered no Internet-based courses through partnerships with colleges and universities. The distributions were fairly similar across institution locale (urban, 60%; suburban, 51.7%; rural, 47.3%), with most institutions using no partnerships for their Internet-based CTE courses.

Internet Technologies Used in Postsecondary CTE

Current technologies in use. The community colleges that offered CTE distance learning courses were asked about the technologies they used in their CTE Internet-based courses. As shown in Table 7, the most frequently used technologies were e-mail (94.3%), course management systems such as Blackboard® and WebCT® (84.2%), and asynchronous discussion lists (64.2%). The least frequently used technologies included high-bandwidth technologies such as desktop videoconferencing (16.1%), voice chat (13.7%), streaming video (37.7%), streaming audio (44.5%), and streaming PowerPoint® (47.3%). Accordingly, a high percentage of community colleges reported no use of high-bandwidth technologies such as desktop videoconferencing (83.9%), voice chat (86.3%), streaming video (62.2%), streaming audio (55.6%), and streaming PowerPoint® (52.7%).

Anticipated utilization of technology. The community colleges that offered CTE distance learning courses were also asked about the technologies they planned to use in their distance CTE courses within the next 3 years. Table 8 and Figure 1 show that the responding community colleges anticipate an increased use of both high-bandwidth and low-bandwidth technologies. Increases in the high-bandwidth technologies include streaming audio/video (87%) and streaming media synchronized with PowerPoint® slides (80.8%), while the low-bandwidth technologies include Internet courses with asynchronous interaction (79.3%), CD-ROM/DVD (77.2%), and asynchronous discussion lists or bulletin boards (72.5%). Most of the responding institutions (81.5%) reported that the use of course management systems is expected to increase.

Table 6

Percentage of Internet-Based CTE Courses Provided Through External Providers and Partnerships

			Number of Courses		
External Providers	*n*	None	1–25	26–50	51–100
All Institutions	172	69.2	11.0	5.2	14.5
Region					
East	71	64.8	14.1	4.2	16.9
Midwest	51	76.5	3.9	5.9	13.7
West	50	68.0	14.0	6.0	12.0
Institution Locale					
Urban	68	70.6	11.8	5.9	11.8
Suburban or Large Town	56	67.9	14.3	1.8	16.1
Rural	48	68.8	6.3	8.3	16.7
Institution Size					
1,000 or fewer	9	66.7	0	0	33.3
1,001–3,000	48	68.8	4.2	6.3	20.8
3,001–10,000	81	66.7	17.3	3.7	12.3
More than 10,000	34	76.5	8.8	8.8	5.9
Partnerships	*n*	None	1–25	26–50	51–100
All Institutions	185	53.5	27.0	3.8	15.7
Region					
East	77	54.5	24.7	2.6	18.2
Midwest	59	45.8	35.6	1.7	16.9
West	49	61.2	20.4	8.2	10.2
Institution Locale					
Urban	70	60.0	21.4	2.9	15.7
Suburban or Large Town	60	51.7	33.3	3.3	11.7
Rural	55	47.3	27.3	5.5	20.0
Institution Size					
1,000 or fewer	12	41.7	8.3	16.7	33.3
1,001–3,000	57	43.9	29.8	1.8	24.6
3,001–10,000	82	59.8	29.3	2.4	8.5
More than 10,000	34	58.8	23.5	5.9	11.8

Table 7

Percentage of Technology Use in Internet-Based CTE Courses

Distance Learning Technology	*n*	Ranges of Technology Use 0%	1–25%	26–50%	51–75%	76–100%
Low-Bandwidth Technologies						
E-mail	174	2.9	1.7	1.1	0	94.3
Course Management Systems	190	4.2	2.1	4.2	5.3	84.2
Asynchronous Discussion	162	8.0	5.6	6.8	15.4	64.2
Text Chat	136	26.5	38.2	12.5	3.7	19.1
CD-ROM	142	22.5	58.5	8.5	2.8	7.7
High-Bandwidth Technologies						
Streaming Video	127	62.2	29.9	4.7	0	3.1
Streaming Audio	126	55.6	38.1	2.4	1.6	2.4
Streaming PowerPoint®	131	52.7	35.1	9.9	0	2.3
Voice Chat	117	86.3	7.7	2.6	1.7	1.7
Desktop Videoconferencing	118	83.9	15.3	0	0	.8

Note. Table indicates the percentage of responding institutions within ranges of use of a specific technology.

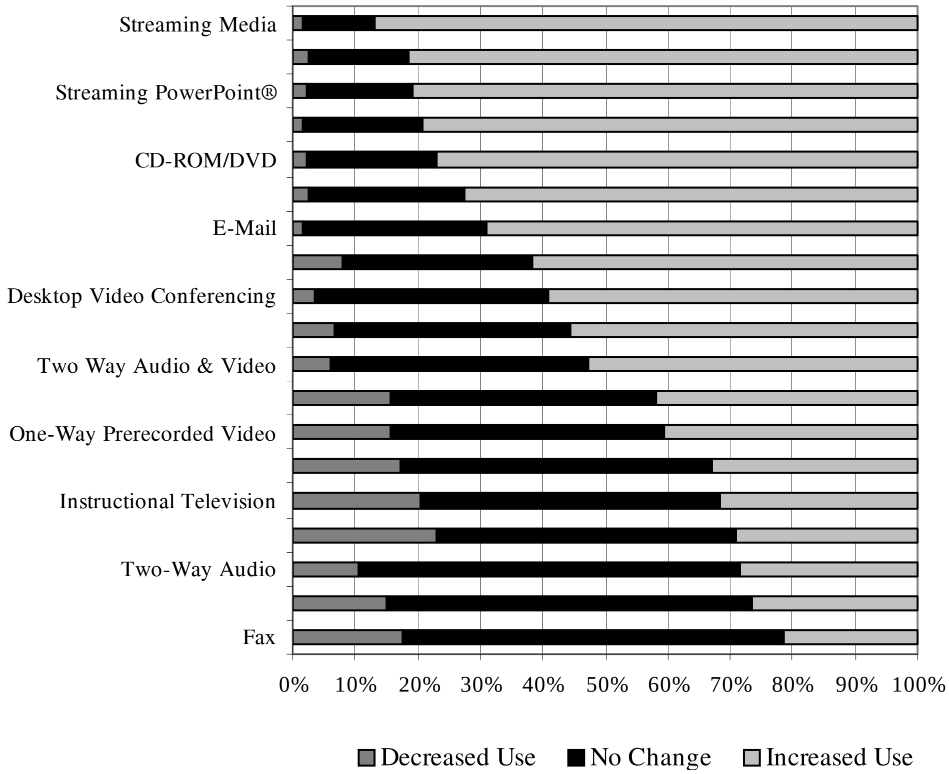
Table 8

Future Use of Technologies by Colleges that Currently Offer Distance CTE Courses

Technologies for Distance Learning in CTE	*n*	Decreased Use	No Change	Increased Use
Low-Bandwidth Technologies				
Course Management Systems (e.g., WebCT®)	200	2.5	16.0	81.5
Internet Courses with Asynchronous Interaction	198	1.5	19.2	79.3
CD-ROM/DVD	184	2.2	20.7	77.2
Asynchronous Discussion Lists or Bulletin Boards	193	2.6	24.9	72.5
E-Mail	191	1.6	29.3	69.1
Synchronous Text Chat	164	6.7	37.8	55.5
Video/Audio Tapes	169	23.1	47.9	29.0
Fax	160	17.5	61.3	21.3
High-Bandwidth Technologies				
Streaming Media (Audio and/or Video)	177	1.7	11.3	87.0
Streaming Media Synchronized with PowerPoint®	172	2.3	16.9	80.8
Internet Courses with Synchronous Interaction	185	8.1	30.3	61.6
Desktop Videoconferencing	166	3.6	37.3	59.0
Two-Way Audio/Two-Way Video	168	6.0	41.4	53.0
One-Way Prerecorded Audio	146	15.8	42.5	41.8
One-Way Prerecorded Video	153	15.7	43.8	40.5
One-Way Live Video	140	17.1	50.0	32.9
Instructional Television	162	20.4	48.1	31.5
Two-Way Audio	144	10.4	61.1	28.5
One-Way Live Audio	140	15.0	58.6	26.4

Note. Table indicates the percentage of responding institutions that projected the use of a specific technology will decrease, increase, or remain the same.

Figure 1. Anticipated increases/decreases in the use of technologies for CTE courses offered at a distance.



Conclusions and Discussion

Internet-based courses are the most prominent form of distance learning in community college CTE programs, especially in credit courses. It may be useful for benchmarking purposes to know that community colleges teach an average of 36 credit and 67 noncredit CTE courses via the Internet. However, the important finding is the large proportion of the CTE courses taught via distance learning being delivered using the Internet. The Internet courses represent nearly three-fourths of all of their distance credit courses and nearly half of their noncredit courses. Given that the feasibility of using the Internet is a fairly recent phenomenon, these data show that the community colleges have made significant progress in developing Internet-based courses in a short amount of time. These data also imply that other forms of distance learning delivery (e.g., correspondence courses, interactive television) are being replaced by Internet-based courses.

The findings from this study also show that the use of the Internet for course delivery has increased dramatically in recent years, particularly in CTE programs. This study found that 95.1% of community colleges offer CTE credit courses via the Internet and 41.1% offer noncredit CTE courses via the Internet. In contrast, Green (2000) found that 74% of community colleges were using the Internet for course delivery. It is important to note that Green's study focused on community college programs and courses in general, while this study focused solely on CTE courses and programs.

Many colleges that offer CTE courses through distance learning are not using the Internet as a delivery vehicle for non-credit courses. In spite of the fact that the majority of colleges are using the Internet for the delivery of CTE courses, there are still a number of institutions that offer no CTE courses via the Internet, especially in noncredit CTE courses. Over half of the institutions that offer some form of distance CTE had no Internet-based noncredit courses. It is unclear why the community colleges use the Internet for the majority of their credit courses (74.8%) but fewer than half use it for their noncredit courses (46.6%). The data clearly show that the lack of Internet-based noncredit courses is neither a function of institution size or locale. The differentiation between credit and noncredit courses might be the result of having more noncredit courses (67 per institution) than credit courses (36 per institution) already developed for "traditional" distance delivery, and it could be too costly in terms of time and money to redesign courses for the Internet when they are already effective in their current format. It could also be that many of the noncredit courses are standardized for certification purposes (e.g., Microsoft or Cisco training) and modification of the courses is outside the authority of the college faculty. If part-time faculty are the ones most likely to teach the noncredit courses, then it is possible that they have neither the time, the expertise, nor the authority to redesign courses for Internet delivery. It is also possible that the noncredit courses are more skill-based than the credit courses, which may make them less feasible to offer online. More research is needed to determine why the noncredit CTE courses are less prevalent in distance learning.

Community colleges are partnering with external providers (e.g., commercial vendors) and other colleges and universities to make credit and noncredit CTE courses available to students. According to the survey findings, nearly one third of all credit and noncredit courses were made available to students via external providers and more than half of the colleges had established partnerships with other colleges and universities. Smaller community colleges (those with 3,000 or fewer students) used this service more than the larger institutions.

Faced with competitive markets, businesses frequently form joint ventures as a way to share strengths and pool resources (Pocorobba, 1999). Community colleges are forming partnerships with external providers and other colleges and universities for similar reasons. They may enter into a simple partnership with a software provider to develop a set of courses (Rinear, 2002) or they may enter into a complex partnership by becoming members of a multi-institution consortium that may be regional, national, or international in scope. According to the NCES (2003), 60% of 2-year institutions that offered distance learning courses in 2000–2001 participated in some type of distance learning consortium (state, system, regional, national, or international).

Internet-based CTE courses in the community college currently rely on low-bandwidth technologies. Although community colleges are actively involved in the delivery of CTE courses using the Internet, they are using what can be classified as "low-bandwidth" technologies. The most common technologies being used in Internet-based CTE courses are course management systems, e-mail, text chat, and asynchronous discussion. What is lacking in these technologies is the ability to incorporate multimedia and real-time exchange of information among individuals or groups within a course. Very few of the colleges are using the high-bandwidth technologies in their Internet-based CTE courses. These types of technologies include streaming audio and video that may be synchronized with presentations (e.g., PowerPoint®), real-time voice chat, and desktop videoconferencing. By taking advantage of fast connection speeds, these technologies make it possible to include multimedia and real-time exchanges of voice and images.

Why aren't the community colleges taking advantage of the cutting edge technologies in their CTE Internet-based courses? There are likely a variety of reasons for this. First, numerous studies comparing traditional classroom-based instruction with technology-supported instruction have found no significant differences on critical educational variables such as learning outcomes and student satisfaction (Russell, 1999). Those involved in the field of instructional technology now conclude that the technology used in an online program is not as important as other instructional factors, such as pedagogy and course design (Phipps & Merisotis, 1999). Just because a technology is not "cutting-edge" does not mean that it is not an effective tool for education. The colleges may also have purposely selected low-bandwidth technologies with the end user in mind. High-bandwidth technologies demand a fast connection speed for the end user as well as a computer that has a fast processor and lots of memory and file storage space. Incorporating high-bandwidth technologies into CTE courses may prevent students from participating because they do not have access to the computers or Internet connections needed to support these more advanced technologies. Since the colleges are using distance learning to attract nontraditional students, their decision to design their distance learning courses around the lowest common denominator is probably an appropriate choice.

Growth is expected in virtually all forms of Internet-based CTE courses and technologies within the next 3 years. Most community colleges expect to see continued growth in the development and delivery of Internet-based CTE courses. These future courses will see expanded use of course management systems, asynchronous discussion technologies, CD-ROM/DVD for the delivery of course content, and streaming media for delivery of live or recorded audio and video. It can be expected that the CTE courses taught via distance learning in the future will rely less on the exchange of audio and video tapes, fax machines, instructional television, and one-way live audio or video.

A significant portion of community college CTE courses is offered via distance learning. Distance courses, on average, comprised nearly one fifth of the total credit and one fifth of the noncredit CTE courses offered at community colleges. These numbers suggest that both credit and noncredit programs have made inroads in the development of distance CTE courses. Since current and previous NCES distance learning studies focused solely on credit-granting courses, the data from this study become the first to illuminate the extent to which the noncredit offerings on the community college campus are provided through distance learning. More research needs to be directed towards this understudied area.

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Factorial Invariance of the Occupational Work Ethic Inventory (OWEI)

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Abstract

This study compared factor structures of the Occupational Work Ethic Inventory (OWEI) for self-perceived work attitudes of manufacturing employees and their supervisors' ratings of those same employees. The purpose of the study was to evaluate construct validity through comparative factor analysis. Four factors were generated through principal components analysis and compared across the groups using the Coefficient of Congruence, the Salient Similarity Index, and the Root Mean Squares methods for comparing factors. Results indicated that the factors measured by the OWEI were virtually the same, for both groups, providing evidence of construct validity for this instrument.

In the rather arid research area of work ethic/work attitudes, the Occupational Work Ethic Inventory (OWEI) developed by Petty (1995) is a notable addition. Funded by a National Science Foundation grant, it was based on prior research works on work ethic, the value of work, and affective work competencies (Hill, 1997). It is a 50 item instrument in which 11 items were reversely stated. The instrument measures work attitudes by asking respondents to indicate on a 7-point Likert-type scale how they can describe themselves at work. Some of the descriptors used are "dependable", "stubborn", "independent", "accurate", and "ambitious". Content validity of the instrument was established through the use of items selected from a review of literature regarding work attitudes, work values, and work habits and through the use of a panel of experts in its construction (Hill, 1997; Petty, 1995). According to Hill (1997), criterion validity was partially addressed in the construction of the instrument by a panel of experts, but he cautioned that further research is needed to establish additional evidence for validity.

We have known for some time that good work attitudes, values, and habits are important to workers and employers. Research has indicated that in the majority of cases where persons lost their jobs or failed to be promoted, the reasons were poor work attitudes and not lack of technical competence (Beach, 1982; Custer & Claiborne, 1992, 1995; Gregson & Bettis, 1992). Good work attitudes are traits that employers want their employers to have (Commission on the Skills of the American

Workforce, 1990), but they may be changing. Yankelovich and Immerwahr (1984), found in younger workers a decline in the belief that good work would be rewarded, suggesting that the younger workers may have less organizational loyalty then their older colleagues. If Career and Technical Education (the successor to Vocational Education) is to succeed in producing graduates who can gain and hold employment in a competitive world, it must succeed in enhancing their work ethic in addition to their technical skills. In order for work attitudes to be improved in students, these skills must be taught. In order to know the extent to which they exist in students before they enter the labor market, good work attitudes must be measured. The OWEI attempts to do this. It measures four constructs thought to embody the main components of work ethic.

A construct is a non observable trait, such as intelligence, which explains behavior and can explain certain differences between individuals (Gay, 1996). For occupational programs, construct validity helps in answering the question, "What does an individual's score on this instrument really mean and how can it be explained in terms of known type of human behavior or psychological constructs?" (Erickson & Wentling, 1988). Logical study of the instrument and intuitive identification of psychological constructs that it measures, and then testing of those constructs, may be a method to establish construct validity. In 1994, Petty and Hill disclosed four dimensions (constructs) of the OWEI using a content analysis and by use of another panel of experts. However, there was no follow-up research study to establish that these four dimensions actually represent the underlying psychological constructs of the OWEI.

One method of evaluating construct validity is through factor analytic techniques (Anastasi, 1976; Reschly, 1978). Although several factor analytic studies on the OWEI were available in the literature (Azam, 2002; Hatcher, 1995; Hill, 1996; Hill & Petty, 1995; Petty, 1995), none on factor comparison were observed. The purpose of this study was to evaluate the construct validity of the OWEI through comparative factor analysis.

Method

Factor structures compared in this study came from two factor analytic studies. In one study (Study 1), the OWEI factor structure was obtained by conducting a principal component analysis of self perceived work attitudes of employees (n=454) in medium size manufacturing industries in the central Illinois area. The OWEI was used to measure employee work attitudes. A second principal component analysis was conducted to ascertain the factor structure of the OWEI when supervisors of the employees (n=581) described earlier rated these same employees' work attitudes with the same instrument (Study 2).

The Principal Components analyses used data without applying any type of transformation or removal of outliers. To ascertain number of factors, both Kaiser's criterion and Cattell's Scree Test were applied. However, Kaiser's criterion retained too many factors (11 for Study 1 and 6 for Study 2). Cattell's Scree Test, which is said to be more accurate than the Kaiser criterion (Zwick & Velicer, 1986), was therefore, used to identify the number of factors. The Scree Test retained four factors in each of the two studies. It could be argued that oblique rotation was called for because the factors would be correlated in the real world. However, benchmark studies using this instrument provided the factors to be compared with ours, and these earlier studies all used orthogonal rotation to generate their factors. Therefore, we rotated our factors orthogonally. With uncorrelated factors, the explanation and interpretation of research results are simpler, less ambiguous, and generally more straightforward (Kerlinger & Pedhazur, 1973). Comrey (1973) suggested that loadings in excess of 0.71 (accounting for 50% variance) are considered excellent, 0.63(40%) very good, 0.55(30%) good, 0.45 (20%) fair, and 0.32(10% of variance) poor. Even though some authors accept loadings as low as 0.3, from a variance perspective Comrey's guidelines make better sense. In this study, a loading of .45, which represents 20% of the variance, was used to include a variable in the definition of a factor. Table 1 and Table 2 gives factor loadings in descending order of loading size for the four factor solutions for Study 1 and Study 2 respectively.

Procedure

Based on the criteria described in the preceding paragraph, four salient and meaningful factors were identified in each of the two studies. Factors obtained in the first study (industrial workers) were named as Teamwork (Factor 1), Dependability (Factor 2), Ambition (Factor 3), and Self-Control (Factor 4). These factors were then compared with four factors obtained in the second study (industrial supervisors). A preliminary matching of factors was made by use of marker variables. Marker variables are those variables that have high loadings (usually 0.5 or above) in the pairs of factors to be compared. Marker variables paired Factor 1 with Factor 2, Factor 2 with Factor 3, and Factor 3 with Factor 1, Factor 4 with Factor 4 of the first and second studies respectively. This method reduced the chance of obtaining spuriously significant results that capitalized on chance relationships. Pattern-magnitude similarities of the factor loadings were then compared.

Factor comparisons using the coefficient of congruence are quite common in literature (Carroll, Houghton, & Baglioni, 2000; Cordano, Scherer, & Owen, 2003; Ommundsen, Hak, Morch, Larsen, & Veer, 2002; and Sakamoto, Kijima, Tomoda, & Kambara, 1998). Likewise, factor comparisons using Cattell's Salient Similarity Index are also not uncommon in the literature (William's & Potter, 1994; Zack, Toneatto, & Streiner, 1998). Guadagnoli and Velicer (1991) found the Salient Similarity Index to be more reliable than the Coefficient of Congruence when comparing factors. However, Cattell (1978) advised the use of at least two methods of factor comparison when matching factors. For this reason, comparisons were

Table 1

Rotated Component Matrix (Study 1)

Variable	Component			
	1	2	3	4
Dependable	0.125	0.667	0.157	0.127
Stubborn	0.317	-0.025	-0.010	0.361
Following regulations	0.208	0.605	0.012	0.232
Following directions	0.239	0.617	0.054	0.223
Independent	-0.001	0.500	0.220	-0.032
Ambitious	0.265	0.460	0.467	0.092
Effective	0.113	0.635	0.322	0.079
Reliable	0.198	0.669	0.183	0.158
Tardy	-0.053	0.185	0.079	0.223
Initiating	0.033	0.250	0.527	0.115
Perceptive	0.141	0.449	0.500	0.112
Honest	0.279	0.588	0.044	0.196
Iresponsible	0.065	0.290	0.190	0.350
Efficient	0.032	0.496	0.464	0.147
Adaptable	0.281	0.496	0.289	0.067
Careful	0.289	0.618	-0.063	0.102
Appreciative	0.432	0.379	0.158	0.257
Accurate	0.150	0.510	0.407	0.093
Emotionally stable	0.405	0.222	0.171	0.466
Conscientious	0.363	0.349	0.273	0.318
Depressed	0.152	0.041	0.179	0.556
Patient	0.456	0.080	0.090	0.288
Punctual	0.264	0.302	0.294	0.060
Devious	0.062	0.012	0.072	0.699
Selfish	0.258	0.175	0.032	0.591
Negligent	-0.021	0.331	0.151	0.497
Persevering	0.071	0.014	0.445	0.073
Likeable	0.637	0.188	0.137	-0.013
Helpful	0.638	0.297	0.284	0.046
Apathetic	-0.175	-0.138	0.086	0.160
Pleasant	0.741	0.083	0.043	0.186
Cooperative	0.627	0.303	0.115	0.155
Hard working	0.365	0.323	0.273	-0.028
Rude	0.379	0.133	-0.001	0.608
Orderly	0.295	0.288	0.361	0.146
Enthusiastic	0.460	0.060	0.562	0.235
Cheerful	0.626	0.107	0.302	0.260

table continues

Variable	Component			
	1	2	3	4
Persistent	0.301	0.221	0.607	0.048
Hostile	0.225	0.090	0.065	0.691
Dedicated	0.503	0.075	0.592	0.195
Devoted	0.564	0.146	0.519	0.161
Courteous	0.723	0.177	0.207	0.214
Considerate	0.650	0.092	0.262	0.301
Careless	0.021	0.269	0.140	0.447
Productive	0.276	0.220	0.485	0.132
Well groomed	0.413	0.268	0.206	0.080
Friendly	0.769	0.122	0.210	0.224
Loyal	0.657	0.108	0.353	0.166
Resourceful	0.437	0.191	0.596	0.143
Modest	0.430	0.154	0.069	-0.067

Table 2
Rotated Component Matrix (Study 2)

Variable	Component			
	1	2	3	4
Dependable	0.369	0.232	0.688	0.110
Stubborn	-0.027	0.477	-0.001	0.537
Following regulations	0.282	0.451	0.522	0.251
Following directions	0.411	0.391	0.563	0.191
Independent	0.672	-0.044	0.243	-0.117
Ambitious	0.784	0.230	0.143	0.148
Effective	0.684	0.250	0.433	0.131
Reliable	0.468	0.213	0.683	0.150
Tardy	0.047	-0.023	0.588	0.334
Initiating	0.773	0.131	0.014	0.118
Perceptive	0.725	0.058	0.228	0.168
Honest	0.267	0.485	0.446	0.305
Irresponsible	0.368	0.120	0.390	0.579
Efficient	0.671	0.230	0.433	0.109
Adaptable	0.500	0.443	0.295	0.192
Careful	0.328	0.365	0.572	0.037
Appreciative	0.366	0.617	0.232	0.249
Acurate	0.486	0.265	0.542	0.069

table continues

Variable	Component			
	1	2	3	4
Emotionally stable	0.184	0.518	0.485	0.239
Conscientious	0.465	0.393	0.485	0.256
Depressed	0.181	0.351	0.234	0.472
Patient	0.029	0.524	0.297	0.217
Punctual	0.138	0.226	0.755	0.088
Devious	0.119	0.271	0.140	0.699
Selfish	0.325	0.284	0.005	0.661
Negligent	0.285	0.138	0.312	0.695
Persevering	0.598	0.157	0.155	0.126
Likeable	0.283	0.723	0.272	0.203
Helpful	0.522	0.505	0.296	0.198
Apathetic	0.343	0.044	-0.003	0.216
Pleasant	0.211	0.791	0.195	0.246
Cooperative	0.322	0.682	0.285	0.283
Hard working	0.631	0.340	0.341	0.296
Rude	0.073	0.465	0.071	0.695
Orderly	0.543	0.221	0.277	0.182
Enthusiastic	0.700	0.434	0.010	0.141
Cheerful	0.389	0.734	0.091	0.171
Persistent	0.649	0.289	0.255	0.076
Hostile	-0.054	0.388	0.120	0.649
Dedicated	0.717	0.374	0.170	0.175
Devoted	0.698	0.401	0.117	0.166
Courteous	0.290	0.739	0.204	0.320
Considerate	0.244	0.713	0.171	0.367
Careless	0.319	0.084	0.263	0.573
Productive	0.647	0.272	0.342	0.214
Well groomed	0.309	0.368	0.319	0.132
Friendly	0.221	0.811	0.199	0.186
Loyal	0.606	0.485	0.159	0.171
Resourceful	0.745	0.251	0.280	0.090
Modest	0.189	0.428	0.053	0.082

made using the Coefficient of Congruence method as well as the Salient Similarity Index (SSI) method. The Root Mean Square Coefficient (RMS), another stringent method of comparing factors, was also used (Rummell, 1970). Significance values for the coefficient of congruence and Salient Similarity Index were obtained from tables provided by Cattell (1978).

Results

Harman (1976) recommended that each factor of one study be compared with all the factors of the other study, and paring each factor with the one with which it has the highest coefficient of congruence. Application of this method resulted in factor pairs that were similar to the pairings obtained using marker variables. Therefore, four comparisons were made with factors from studies 1 and 2. Comparisons were made using the Coefficient of Congruence (r_c), the Salient Similarity Index (s) and the Root Mean Square Coefficient (μ). Results of the comparisons are given in Table 3.

Table 3

Factor comparisons by RMS coefficient, Coefficient of Congruence, and Salient Similarity Index

Compared Factors		RMS Coefficient (μ)	Coefficient of Congruence		Salient Similarity Index		
1st study	2nd Study		Value (r_c)	*P*	Value (s)	% hp Count	*P*
Factor 1	Factor 2	0.119	0.960	<0.001	0.900	68	<0.001
Factor 2	Factor 3	0.204	0.940	<0.001	0.690	58	<0.001
Factor 3	Factor 1	0.151	0.903	<0.001	0.960	74	<0.001
Factor 4	Factor 4	0.105	0.956	<0.001	0.940	82	<0.001

The Root Mean Square Coefficient can have any value between 0 and 2, although values of 0 or 2 are extremely unlikely to occur. If μ is zero, the two factors are alike in magnitude and direction. As μ departs from zero, the factors are less alike. In these four comparisons, the values of μ varied from 0.105 to 0.204 (See Table 3). The small values obtained for μ suggested that the four factors were alike across the populations (Rummell, 1970). However, as there is no set standard as to what value of μ indicates an acceptable agreement between factors, it was not used as the primary basis for making a decision on factor similarity.

Values for the Coefficient of Congruence varied from 0.903 to 0.960 (See Table 3). According to Broadbooks and Elmore (1987), an obtained sample congruence coefficient greater than 0.50 will usually be an underestimate of actual population value. Therefore, the actual population coefficients of congruence may be even higher than the values obtained here. The Coefficient of Congruence ranges from –1.00 (for perfect negative similarity) through zero (for complete dissimilarity) to 1.00 (for perfect positive similarity). The critical value of the coefficient of congruence at $P < 0.05$ with 50 variables in common and 4 factors is 0.34 (Cattell, 1978). The minimum coefficient value obtained from the four comparisons was 0.903, suggesting a very strong match. However, this does not imply that the factors of the two studies were exactly identical. They are congruent to some extent. The literature recommends different criteria to express the extent of congruence. Ommundsen et al. (2002) treated a 0.80 coefficient of congruence as robust. Sakamoto et al. (1998) described coefficient of congruence values of 0.90 or above as representing very high, 0.80 – 0.89 as high, and 0.70 – 0.79, as moderate agreement. On the other hand, Koschat and Swayne (1991) judged factors to be virtually equal whenever the Coefficient of Congruence was 0.85 or above.

Salient similarity indices and hyperplane counts were calculated for the same four comparisons according to the method given by Cattell (1978) (See Table 3). With 50 variables and a corresponding hyperplane (hp) count, the p value obtained was $P < 0.001$. These results were consistent with the results obtained by comparing the factors using the Coefficient of Congruence method, although the probability level for the congruence method was different (at $P<0.05$).

Table 4 presents subgroup (factor) reliability indices (Cronbach's alpha). Nunnally (1978) indicated 0.7 to be an acceptable reliability coefficient though lower thresholds are sometimes used in the literature. George and Mallery (2003) provided the following rules of thumb: >0.9 as Excellent; >0.8 as Good; >0.7 as Acceptable; >0.6 as Questionable; >0.5 as Poor, and <0.5 as Unacceptable. In both cases, subgroup reliability indices were found to be well within acceptable limits.

Table 4
Subgroup (Factor) Reliability Indices (Cronbach's Alpha)

	Factors (Study 1)				Factors (Study 2)			
	F1	F2	F3	F4	F1	F2	F3	F4
Cronbach's Alpha	0.93	0.89	0.87	0.80	0.96	0.95	0.92	0.89

Discussion

Four comparisons were made using the Coefficient of Congruence and the Salient Similarity Index and the results obtained by the two methods agreed at $P < 0.05$. Comparisons made using the root mean square method appear to be consistent with these results. Therefore, we concluded that the OWEI factors are replicable in different populations and that evidence exists for construct validity of this instrument. We believe that others can use these factors with confidence and without fear of population bias in their research. Also, we observed in this study that marker variables could play a very deciding role in the pairing of factors. In particular, we noted that those factors which were paired on the basis of commonality in marker variables yielded the largest coefficients of congruence *in every case*. Another important feature of this study is that the factor structures compared were not only obtained for different populations (workers and supervisors) but also in terms of the method with which responses were collected. Work attitudes were measured by self-evaluation (Study 1) and evaluation by others (Study 2). This leads us to believe that, irrespective of evaluation method, the constructs of the OWEI are replicable. The comparatively high reliability indices for the factors in both studies indicate that the internal consistency of the factors is high. This is consistent with the evidence for construct validity of this instrument.

This study was conducted in a manufacturing environment. The data used in the analysis were obtained from manufacturing employees in the central Illinois area. A randomized block design was used to select the industries studied because we wanted to increase generalizability of results. However, it cannot be assumed that the same results will occur for other groups. The constructs represented in the OWEI may remain constant for other populations, but this hypothesis should be confirmed by additional research. It is possible that work ethic differs among occupational areas, populations, communities and perhaps even organizations. There may even be multiple work ethics possessed by different people and groups within the same occupational area. We hope that subsequent research will shed light on these and other questions concerning the measurement of work attitudes, values, and habits.

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A Comparison of Students' Achievement and Attitudes between Constructivist and Traditional Classroom Environments in Thailand Vocational Electronics Programs

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Abstract

The purpose of this quasi-experimental study was (a) to determine if there was a difference in knowledge achievement by Thailand's vocational students instructed using constructivist instruction (with open-end dialogue, problem-based learning, and cooperative learning) and using traditional instruction (with lectures, directed demonstrations, and scripted experiments); and (b) to identify whether Thai vocational students preferred instruction modeled upon constructivist philosophy rather than traditional instructional philosophy.

The target population consisted of students participating in electronics courses. The sample was students who attended the Electronics Measurement and Instrument course at two selected technical colleges in central Thailand. Two intact classes at each college received both treatments (counterbalanced design). There were 108 students used as the sample in the study.

An effect size and an ANCOVA were used to test the first research question. There was no statistical difference between the achievement scores of the students receiving constructivist instruction and those receiving traditionally instructed students. However, the constructivist-instructed students had higher scores on the posttest and the delayed posttest, compared to those of the traditionally instructed students.

The samples mean scores, standard deviation, percentages, and opinions on surveys were used to compare results for the second research question. The findings showed that there was a significant difference in student preferences. Students preferred constructivist instruction.

Introduction

For over three-quarters of a century, the implicit learning theory and pedagogy of vocational education has been behaviorism, but today the theory of constructivism has positive implications. Using a constructivist approach, teachers facilitate learning by encouraging active inquiry, guide learners to question their tacit assumptions, and coach them in the construction process. Doolittle and Camp (1999) stated teaching and learning that help the learner become involved and involve the teacher as a learning facilitator are opening the doors to knowledge development and application in both academic and vocational education.

Cognitive theorists believe the role of the teacher is to provide learners with opportunities and incentives to learn, holding that among other things:

1. all learning, except for simple rote memorization, requires the learner to actively construct meaning;
2. students' prior understandings and thoughts about a topic or concept before instruction exert a tremendous influence on what they learn during instruction;
3. the teacher's primary goal is to generate a change in the learner's cognitive structure or way of viewing and organizing the world; and
4. learning in cooperation with others is an important source of motivation, support, modeling, and coaching (Feden, 1994, p. 19).

The constructivist theory of learning supports cognitive pedagogy, proposing that humans have an innate sense of the world and this domain allows them to move from passive observers to active learners. Carlson (2003) supports a strong emphasis on identifying, building upon, and modifying the existing knowledge (prior knowledge) students bring to the classroom, rather than assuming they will automatically absorb and believe what they read in the textbook and are told in class.

Today, a major concern of adult, career, and vocational educators is the educational preparation of those entering the work force. In a workplace that is characterized by new management systems, production processes, and global competitiveness, employers are demanding their workers have cognitive skills in critical thinking, problem solving, and conflict negotiation, as well as high-level technical and basic academic skills (Applebaum & Berg, 1999; Schmidt, 2000). Workers must be able to organize social and technological resources to acquire new knowledge, a "process that requires knowing how to identify the limits of one's own knowledge, how to ask germane questions, how to penetrate poor documentation, and how to identify sources of information" (Berryman, 1990, p. 8).

According to Billett (1996), the preparation of workers for entry-level jobs and advancement in the workplace requires educational programs that provide not only job skills, but also higher-order thinking, problem solving, and collaborative work skills. Doolittle and Camp (1999) indicated that traditional learning-teaching approaches in vocational education do not adequately address the latter kinds of learning, but constructivist theory does. In addition Doolittle and Camp added constructivist learning environments offer the potential for locating learning in the context of real-life situations and problems. Such environments offer a rationale for curriculum integration that connects learning with the workplace. Learning is facilitated through the design of classroom activities that guide students to work collaboratively with others, set their own sequences and pace of work, and actively engage in problem solving, critical thinking, and negotiation. It allows learners to move from passive observers to active learners who "construct knowledge by integrating new information and experiences into what they have previously come to understand, revising and reinterpreting old knowledge in order to reconcile it with the new" (Kerka, 1997, p. 1).

Need for the Study

Today in Thailand, the public is demanding the nation's schools provide effective education to keep pace with a rapidly changing world. Section 22 of the current National Educational Act (Office of the National Education Commission, 1999) states that:

> Education shall be based on the principle that all learners are capable of learning and self-development, and are regarded as being most important. The teaching-learning process shall aim at enabling the learners to develop themselves at their own pace and to the best of their potentiality. (p. 6)

This statement assures that each individual has the potential for learning and is regarded as the center of teaching-learning activities.

"Research supports the concept that most teachers teach the way they learn" (Stitt-Gohdes, 2001, p. 136). Brown (2003) indicated that typically these teachers are field independent, that is, they are more content-oriented and prefer to use more formal teaching methods. Research in education indicates that rote learning and multiple-choice type tests are not the best methodology for intelligence development. To reform the teaching-learning process, both teachers and learners must change their roles. Teachers must change from being a "dispenser" to a "facilitator," while learners must learn by themselves, learning where to get information and how to make use of it. Thai educators, teachers and administrators are searching for a new approach to help provide students with a learner-centered classroom environment.

In the constructivist-based classroom, teachers coach learners with appropriate scaffolds (instructions, physical aids and supporting materials), gradually decreasing assistance as the learner becomes more independent through continued practice. Learners internalize the process by constructing their own knowledge base and understanding. "Teachers must be cognizant of different learning styles, cultural experiences, and learning needs of the learners, and of the different social environments from which learners come" (McWhorter, Jarrard, Rhoades, & Wiltcher, 1996, p. 25). This type of classroom environment could assist Thai vocational educators in meeting the future needs of their students and of Thailand.

Research studies (Bettencourt, 1993; Cobb, 1994; Dubinsky, 1992) on the effectiveness of the constructivist approach focus on the fields of math, science, and social studies. Thailand's vocational education lacks this research base and there have been no studies investigating whether the constructivist approach is more effective in Thai vocational education when compared to the traditional instructional approach.

The goal of this study was to determine the effects of constructivist instruction on student understanding of electronics concepts. The study provided a systematic comparison of two types of instruction (constructivist and traditional instruction) through achievement measures on a pretest, posttest, and delayed posttest.

Purpose and Objectives

The purpose of this quasi-experimental study was (a) to determine if there was a difference in knowledge achievement by Thai vocational students instructed using constructivist instruction (with open-end dialogue, problem-based learning, and cooperative learning) and using traditional instruction (with lectures, directed demonstrations, and scripted experiments); and (b) to identify whether Thai vocational students preferred instruction modeled upon constructivist philosophy rather than traditional instructional philosophy.

To complete this purpose the following objectives were established:

1. Compare students' achievement of the constructivist approach in Thai vocational education as compared to that of a traditional instructional approach.
2. Determine if Thai vocational students prefer instruction modeled upon constructivist philosophy.

Research Question One

Is there a significant difference in students' knowledge of electronics concepts between Thai vocational students who are instructed using constructivist instruction and traditional instruction as measured by achievement on a pretest, a posttest, and a delayed posttest? In this study the criterion for statistical significance was the accepted $p \leq .05$.

Research Question Two

Do Thai vocational students prefer constructivist instruction to traditional instruction? It is hypothesized that Thai vocational students will prefer constructivist instruction.

Methodology

Setting and Subject Description

College Settings. The study was conducted in two public, technical colleges, located in central Thailand. The colleges were selected because they had electronics programs that met national standards for electronics and were recognized throughout Thailand as being programs that produce successful graduates (students going on for advanced education or students entering the job market). In addition, both colleges' administrators advocate the implementation of innovative teaching strategies that result in a positive impact on student achievement. Both colleges had electronics classrooms equipped with laboratory facilities, computer laboratories, and updated libraries.

Teacher Descriptions. The course used in this study was Electronics Instruments and Measurement. Both teachers used in the study were interested in improved teaching methods, recognized by their peers as excellent teachers, and each was an expert in teaching electronics. One of the participating teachers (Mr. Arun Junhom at Nakhon Pathom Technical College – teacher and college A) had been teaching electronics for 12 years and the other teacher (Mrs. Narumol Pimpak at Minburi Technical College – teacher and college B) had been teaching for 9 years.

Student Descriptions. Two classes of electronics students from each college representing cluster samples, were studied. The cluster samples were selected from a total of five electronics classes. Students in the classes were given the opportunity not to participate in the study. The initial convenience sample consisted of 108 students at the two colleges, along with their respective teachers (teacher A and teacher B). The sample included two intact groups (entire classes) in each college.

All students in this study were in their first year at the diploma level of the electronics programs. The mean age (with standard deviations in parentheses) of the sample was 19.20 (0.49); 19.26 (0.78) for group 1A, 19.29 (0.86) for group 2A, 19.12 (0.61) for group 1B and 19.08 (0.49) for group 2B.

Variables

Independent Variable. The independent variable was classroom instruction, either a traditional or constructivist approach. The researcher ensuring the development of a constructivist approach with both teachers and its subsequent use in the classroom manipulated the independent variable. The two teachers agreed to follow guidelines for the study by designing their instructional activities to reflect the tenets of constructivism or traditional instruction.

Observations of the teachers were conducted during the study to assure that lesson plan objectives and teaching strategies were compliant with the study. Each teacher was observed three times during the study. The researcher observed each teacher two times when they taught using constructivist and the traditional instruction (one for each topic). A constructivist checklist and traditional checklist was used to collect information concerning fidelity of implementation of the treatment.

Dependent Variable. The dependent variables were students' achievement (or content knowledge) and their attitudes toward instruction. A pretest-posttest design was used to collect students' achievement data. All four groups of students were measured three times using the achievement tests. The first measurement (achievement test version 1) was given to the groups as a pretest before the treatments began. The test was used for gathering students' specific knowledge in electronics. Data from the pretest were used as a covariate in subsequent analysis. The second measurement (achievement test version 2) was given to the group as a posttest at the end of the treatments. The third measurement (achievement test version 3) was given to the group as a delayed-posttest three weeks after the treatment.

Design

A quasi-experimental pretest-posttest, nonequivalent control group design was used in the study. Due to the nature of the registration process and enrollment in the Electronics Department at both colleges, randomization was not used in this study.

Huck, Cormier, and Bounds (1974) stated: "Quasi-experimental designs can be used by researchers when true experimental designs are not possible or feasible" (p. 301). In a quasi-experimental design, the researcher does not randomly assign subjects to the treatment or control groups, completely control when the treatment is applied, or completely control when the observations are conducted as in a true experimental design. According to Huck et al., quasi-experimental designs need to "control one or two of following: when the observations are made, when the treatment or independent variable is applied, and which intact group receive treatment" (p. 301).

In this study the clusters were randomly selected to receive the treatment. The participants were not randomly assigned to the experimental and control groups, and both groups took a pretest and a posttest. The research design in this study was a nonequivalent control-group design. This study used a counterbalanced experimental design, which was diagrammed as shown in Table 1.

As diagrammed, O represented a series of measures: O1 represented the pretest 1, O2 represented the posttest 1, and O3 represented the delayed posttest 1. For the second topic, O4 represented the pretest 2, O5 represented the posttest 2, and O6 represented the delayed posttest 2. Also, X represented a series of instructions: Xc1 represented the constructivist instruction for the first topic, Xc2 represented the constructivist instruction for the second topic, Xt1 represented the traditional instruction for the first topic, and Xt2 represented the traditional instruction for the second topic.

Table 1
Nonequivalent Control-Group Design Used in the Study

Group	Pre1	Inst1	Post1	DPost1	Pre2	Inst2	Post2	Dpost2
1 (1B, 2A)	O1	Xc1	O2	O3	O4	Xt2	05	O6
2 (1A, 2B)	O1	Xt1	O2	O3	O4	Xc2	05	O6
	Bridge Topic				Oscilloscope Topic			
	(1^{st} – 4^{th} wk)-- -(4^{th} wk)- -(7^{th} wk)				(5^{th} – 8^{th} wk)-- -(8^{th} wk)- -(11^{th} wk)			

Note. O = A series of measurements, either a pretest, posttest, or delayed posttest. Xc1 represents constructivist instruction for the first topic. Xc2 = constructivist instruction for the second topic. Xt1 = traditional instruction for the first topic and Xt2 = traditional instruction for the second topic.

In this study, each participant (student) was administered both treatments (traditional and constructivist), but the order of administering the treatments was varied across student clusters to eliminate the possible confounding of order effects with treatment effects. The use of the ANCOVA addressed the pretest differences before the treatment. Students in each group were given both treatments.

Instruction

Constructivist Instruction (Xc1 and Xc2). The constructivist instruction was student-centered and provided opportunities for students to construct their own knowledge of the subject. The instruction occurred through a variety of methods including problem-based learning, tutoring, open-ended dialogue, collaborative and cooperative learning. In class, the instruction did not directly cover the textbook materials. Students did not receive specific "lecture" instruction in the subject. The tools used in the study included students working in pairs, students working in groups, a computer and software, reference materials, and the instructor. These tools were used for all groups during each constructivist instruction session.

Traditional Instruction (Xt1 and Xt2). According to Roth (1993), much current teaching is still grounded in an epistemology that is referred to as traditionalism. In the dominant paradigm of secondary science teaching (similar to teaching electronics concepts in Thai vocational education), information is transmitted to students, learning is equated with memorization, and the assessment is summative (Gallagher, 1993). Pedagogy reflecting traditional instruction is the predominant methodology in use today and was considered the control. The control groups of students received traditional instruction (that involved lengthy lectures, directed demonstrations, and scripted experiments). The delivery of instruction was primarily teacher centered, using a lecture format with emphasis on the course textbook.

Instrumentation

Achievement Tests. Two 15-item tests of achievement in understanding certain electronics concepts (version 1, one for the Bridge topic, another for the Oscilloscope topic) were given to the groups as a pretest before the study began. The achievement tests version 2, consisting of 15 items each, was used as a posttest at the end of each topic four weeks later, while the achievement version 3, containing 15 test items each, was used as a delayed posttest after three additional weeks (7th week for the Bridge topic and 11th week for the Oscilloscope topic). The delayed posttest measured the effects of instruction on the amount of information retained over time. Students are able to memorize much information for short periods of time without understanding it. A delayed posttest was used to answer the question of whether there was student memorization of facts and information or whether understanding of the electronic concepts taught by the teachers using different instructional methods affected retention.

The achievement tests were reviewed by the panel of experts which included teacher A and teacher B, two additional electronic teachers, and one professor from Utah State University. Teacher A and teacher B were the experts with knowledge in the content of the course (electronics instrument and measurement) and the electronic technical materials. The two electronics teachers were the experts with knowledge in teaching in vocational electronic programs. The professor was an expert with knowledge in test and curriculum development and educational assessment. Upon review by the panel of experts, slight changes were made for greater clarity.

Constructivist Learning Environment Survey (CLES). The revised CLES test measured student and teacher perception of constructivist attributes in the learning environment (Taylor, Fraser & White, 1994). This instrument was designed to enable researchers to measure constructivist approaches to teaching high school subjects. The results of this survey provided insights into a classroom environment.

The 30-item, 5-point Likert-type questionnaire identified student perceptions of the presence of characteristics of constructivism on five subscales, with six questions each: personal relevance, uncertainty, critical voice, shared control, and student negotiation. The five possible choices for each question and the associated points used for scoring were: “almost always” (5), “often” (4), “sometimes (3), “seldom” (2), and “almost never” (1). The mean scores of the perceived constructivism were used as data to determine a “low” or “high” degree of constructivism in the classroom environment.

The Attitude Scale. The attitude scale was used to assess students’ perception and preferences on teaching approaches. The test was given to students at the same time as the posttest (at the end of the treatment-constructivist instruction). The attitude scale used in this study was adapted from the classroom evaluation form used at Utah State University. The form was developed by a committee consisting of faculty and others, and has been in use for nine years at the university. In addition, forms used at other institutions were carefully studied. The form included items questioning students' enjoyment of and engagement in the activities in the classroom (part 1), students' opinion on quality of instruction, instructor, and materials and equipment (part 2 and 3), and students' opinion on choices of instruction they prefer in the future (part 4). Questions in part 1 had fixed-response options on a five-point Likert-type scale. Questions in part 2 had specific response options on seven choices. In part 3, students responded by giving a short answer. In part 4, students responded by selecting a choice and giving a short explanation.

The Constructivist Checklist. The constructivist checklist was developed to serve as a simple instrument to guide observation in some of the ways in which the constructivist characteristics were presented in the classroom. The checklist was used during observation to determine if the constructivist approach was being translated into practice. These characteristics were based on constructivist theory of learning and epistemology. The checklist was developed by Murphy (1999) and consisted of 18 characteristics to be observed, which were checked among the choices of "supported," "not supported," and "not observed."

The Traditional Checklist. The traditional checklist was developed to serve as a simple instrument to guide observation during traditional classroom instruction (with lectures, directed demonstrations, and scripted experiments). The traditional method is typical in Thai vocational education programs. The checklist consisted of 12 characteristics to be observed, which were checked among the choices of "supported," "not supported," and "not observed."

Instrument Validity and Reliability

The content validity was established though the utilization of a panel of experts. The panel ensured the instruments reflected the various parts of the content domain in appropriate proportions. The reliability correlation values for the CLES and the Attitude Scales were obtained through the statistical application of Cronbach's homogeneity coefficient alpha. van den Bergh (1987) suggested that ". . . an alpha-value of at least more than 0.60 indicates a good reliability of scale" (p. 43). An alpha-value of at least 0.60 was the target number set as a goal for the acceptance of the instruments.

Through the large group study (N = 108) it was found that an overall alpha value of the CLES was 0.85, and an overall alpha value of the attitude scale was 0.92. Therefore, the content validity and the reliability of the CLES and the attitude scale were acceptable for use as an instrument to measure students' perceptions of constructivist attributes in the learning environment.

Validity of the Study

The study was examined for validity based on statistical conclusion validity, internal validity, and external validity.

Statistical Conclusion Validity. Statistical conclusion validity is concerned with the ability of the study to discern a difference between two variables. Investigation of the following concerns supported statistical conclusion validity.

1. Estimated statistical power was not low. The use of the ANCOVA for analysis increases power (Stevens, 1996, p. 92).
2. None of the assumptions of statistical tests was violated for the reported data.
3. Groups, instead of individuals, were used for the unit of analysis.
4. Homogeneity of the groups was increased statistically by using pretest scores as a covariate.

Internal Validity. Internal validity reflects answers to the question “if the two variables covary, is it plausibly causal from operational variable to the other or would the same relationship have been obtained in the absence of any treatment of any kind?” (Cook & Campbell, 1979, p. 39). In other words, to what degree would extraneous variables influence the results of the study, and therefore the conclusions of an investigation? This aspect of a study’s validity is largely a function of its research design. The design of this study was such that generalizability was limited to the two participating colleges or institution very like them.

External validity. The subjects (students) were chosen in a nonrandom manner. They were the students of two electronics teachers from two different colleges who volunteered to work with the researcher. The use of a nonrandom sample of convenience somewhat limits the generalizability of this study’s findings. The nature of this study limits its generalizations to regular vocational students in central Thailand.

Summary and Discussion

There were 108 students in the sample. The sample was representative of typical vocational education students in age and GPA. Table 2 presents the means of the ages and the grade point averages for the sample. All students in the sample were first year students at the diploma level of the electronics programs. The average age of the sample was 19.2 years old. The grade point average of the sample (with standard deviations in parentheses) was 2.52 (0.49). The sample showed a lack of representation in gender with only eight students being female. However, in the regular population of Thai vocational students in electronics programs, the ratio of female to male students is very low. The ratio can be determined through national records. At the time of this study, there were a total of 4,675 male students and 1,584 female students in the diploma level electronics.

Table 2
Mean Ages and Grade Point Averages for the Sample

	Sample	Teacher A		Teacher B	
		Group 1A	Group 2A	Group 1B	Group 2B
Age	19.20 (0.70)	19.26 (0.78)	19.29 (0.86)	19.12 (0.61)	19.08 (0.49)
GPA	2.52 (0.49)	2.70 (0.42)	2.58 (0.46)	2.32 (0.78)	2.40 (0.46)

Note. Standard deviations are in parentheses.

Summary Relevant to Research Question One

The first research question was to determine if there is a significant difference in students' knowledge of electronics concepts between Thai students who were instructed using the constructivist approach to teaching compared to that of the traditional instructional approach. As indicated in Table 3, students who were taught with the constructivist instruction (in group 1 for the first topic) had higher mean scores for both the posttest 1 and the delayed posttest 1. For topic 2, students in group 1, who were taught with constructivist instruction had the highest mean score for the posttest 2 (8.48, $SD = 2.37$) and the delayed posttest 2 (8.37, $SD = 2.45$). For pretest 2, students in group 1, who were taught with traditional instruction had the highest mean score (5.54, $SD = 1.35$). Overall, the lowest mean scores of all tests, except the pretest 1, belonged to the students in group 2, who were taught with traditional instruction.

Table 3 reports the means, standard deviations, and the effect size of the samples' pretest, posttest, and delayed posttest. The mean difference effect sizes (shown as Diff. in the table) were calculated using the formula:

$$ES = (Mean_{constructivist} - Mean_{tradition})/SD_{tradition}$$

As the results in Table 4 show, the differences between groups were not statistically significant. From Table 4, no p value was less than 0.05. The p values of the combined group (0.99 for pretest 1, 0.15 for posttest 1, 0.07 for delayed posttest 1, 0.84 for pretest 2, 0.42 for posttest 2, and 0.35 for delayed posttest 2) were greater than 0.05. There was no statistically significant difference in mean scores of the combined group's pretests, posttests, and delayed posttest between students provided with constructivist instruction and those students receiving traditional instruction. However, the mean scores of the posttest and the delayed posttest of students who were instructed by a constructivist instructional approach were higher, compared to their comparing group in the same college. This pattern or trend occurred at both colleges. Whereas statistical significance may or may not indicate practical significance, an argument might be made that the effect sizes, while less

Table 3

Mean, Standard Deviations, and ES of the Sample's Pretest, Posttest, and Delayed Posttest Scores

Tests	**Group 1 (*N* = 58)**		**Diff.**	**Group 2 (*N* = 48)**		**Diff.**
	Cont.	**Trad.**		**Cont.**	**Trad.**	
Topic 1 (Bridge)						
Pre 1	4.00 (1.38)	3.94 (1.63)	0.04	3.88 (1.42)	3.92 (1.26)	-0.03
Post 1	7.46 (2.67)	6.37 (2.48)	0.44	6.67 (2.90)	6.20 (2.99)	0.16
Delayed Post 1	7.33 (2.61)	6.08 (2.40)	0.52	6.46 (2.60)	5.88 (2.73)	0.21
Topic 2 (Scope)						
Pre 2	5.40 (1.61)	5.54 (1.35)	-0.10	5.04 (1.67)	4.83 (1.71)	0.12
Post 2	8.48 (2.37)	8.12 (3.09)	0.12	7.08 (2.61)	6.79 (3.05)	0.09
Delayed Post 2	8.37 (2.45)	7.79 (3.11)	0.19	6.72 (2.48)	6.54 (3.02)	0.06

Note. Standard deviations are in parentheses. Diff = Difference between means. ES (effect size) is indicated by Diff.

Table 4

Summary Table for the Analyses of Variance on Pretest, Posttest, and Delayed Posttest Scores from Group 1 and Group 2

Tests		*SS*	*df*	*MS*	*F*	Sig.	*ES*
Topic 1	**(Bridge)**						
Pre 1	Between	0.00	1	0.00	0.00	0.99	<0.001
	Within	218.55	106	2.06			
	Total (*N*)	218.55	107				
Post 1	Between	15.50	1	15.50	2.08	0.15	0.28
	Within	789.41	106	7.44			
	Total (*N*)	804.91	107				
Dpost 1	Between	21.40	1	21.40	3.24	0.07	0.35
	Within	698.48	106	6.59			
	Total (*N*)	719.88	107				
Topic 2	**(Scope)**						
Pre 2	Between	0.10	1	0.10	0.04	0.84	0.04
	Within	272.56	106	2.57			
	Total (*N*)	272.66	107				
Post 2	Between	5.20	1	5.20	0.66	0.42	0.14
	Within	839.32	106	7.92			
	Total (*N*)	844.52	107				
Dpost 2	Between	7.12	1	7.12	0.89	0.35	0.16
	Within	841.65	106	7.94			
	Total (*N*)	848.77	107				

that the criterion value of .6, do indicate some differences based on the treatment that may be of practical value.

Summary Relevant to Research Question Two

The second question addressed in this study was to identify whether Thai vocational students preferred constructivist instruction over traditional instruction. The students' responses from the attitude scale in relation to research question two showed that there was a difference in student preferences. Students preferred constructivist instruction.

Table 5 presents the mean scores of the all groups of students who completed the attitude scale after they experienced constructivist instruction. The attitude scale included four sections of items questioning students' perceptions of the constructivist instruction they experienced.

Table 5
Students' Perceptions of Student Enjoyment and Teachers' Role in the Classroom

Item	Description	Sample	
		M	*SD*
	Student Enjoyment		
#1	Interest in lesson	3.89	0.79
#2	Willing to learn	4.10	0.79
#3	Importance of activities	4.09	0.77
#4	Try best	3.85	0.81
#5	Pay attention	3.65	0.74
#6	Enjoy the lesson	3.48	0.88
	Total	3.84	0.53
	Teachers' Role		
#7	Friendliness	3.96	0.87
#8	Helpfulness	3.60	0.93
#9	Interest in problems	3.74	1.14
#10	Goes out of their way	3.39	0.97
#11	Moves around	3.22	1.09
#12	Considers feelings	3.15	1.09
	Total	3.38	0.87

Note. Numbers are represented on a 5-point Likert Scale (5=Almost Always, 4=Often, 3= Sometimes, 2=Seldom, 1=Almost Never). The higher mean score the more positive the student response. *N* = 108.

The first six questions of the attitude scale assessed students' enjoyment of the activities in the classroom. The last six items questioned students' perceptions of their teacher's role in the classroom. The data reported in Table 5 showed that students who experienced the constructivist instruction had positive attitudes about their experience in the classroom and toward their teacher's role.

The total mean score of the teachers' role was 3.38 (0.87). Based on the total sample mean scores of section 1 in Table 5, students experienced enjoyment in the constructivist instruction and perceived the teachers' role positively. Student enjoyment is defined by the questions on the attitude scale (interest in lesson, willing to learn, importance of activities, try best, pay attention, enjoy the lesson). The mean scores of students on their opinion of quality of constructivist instruction, instructor, and materials and equipment (in section 2 and section 3 of the attitude scale) are reported in Tables 6 and 7.

Table 6
Sample Mean Scores of Student Opinions from Section 2 of the Attitude Scale

Item	Description	Sample	
		M	SD
#1	Overall quality of the lesson	3.90	0.53
#2	Teacher' effectiveness	4.04	0.79
#3	Clearness of lesson objectives	3.84	0.74
#4	Relevance of assignments to lesson	4.00	0.66
#5	Relevance of material to lesson	**3.61**[a]	0.72
#6	Appropriateness of workload	3.89	0.70
#7	Relevance of exams to lesson	3.89	0.60
#8	Clearness of students' responsibilities	3.64	0.70
#9	Helpfulness of assigned materials	3.97	0.81
#10	Helpfulness of lesson organization	3.97	0.67
#11	Helpfulness of teacher' explanations	4.25	0.74
#12	Teacher' s use of examples	4.06	0.83
#13	Teacher' use of class time	3.68	0.82
#14	Teacher' enthusiasm for lesson	4.13	0.72
#15	Teacher's helping in resolving questions	3.92	0.78
#16	Teacher was prepared	**4.28**[b]	0.73
#17	Opportunity to ask question	4.12	0.78
#18	Opportunity to make comments	3.89	0.89
#19	Availability of extra help	3.78	0.93
	Total	3.94	0.43

Note. The higher mean score the more positive the student response. Numbers are represented on a 5-point Likert Scale (5=Excellent, 4=Very Good, 3= Good, 2=Fair, 1=Poor). *N* = 108.
[a]The lowest sample mean score. [b]The highest sample mean score.

From the data reported in Table 6, students' opinions on quality of instruction, instructor, and materials and equipment were positive, as the mean score of every item was greater than 3.0, "Good." Students rated all aspects of the quality of constructivist instruction, instructor, and materials and equipment from "good" to "very good." Their opinions on these aspects were positive.

In addition, students were asked to provide their opinions on what aspects of the instruction they perceived as positive and negative. The data shown in Table 7 presents the summary of the aspects and the percentage of students' opinion. Students' involvement (meaning that students had more opportunities to get involved in the classroom) was the aspect that most students perceived as a positive outcome of the constructivist instruction (39.7%). The second most important aspect was the understanding of the topics (27.4%). These results indicated that students participated in class and understood the concepts more in the constructivist instruction.

Table 7

Percentage of Students' (both groups) Opinions from Section 3 (Constructivist Instruction) of the Attitude Scale

Positive		Negative	
Aspects	%	Aspects	%
Students' involvement	39.7	Time constraint	38.7
Understanding of topics	27.4	Overwhelming information	27.4
Materials	12.3	Students' preparation	19.4
Instructional strategies	8.2	Objective clarification	8.1
Teacher effectiveness	6.8	Irrelevant material	3.2
Classroom environment	5.6	Students' pace	3.2

Note. N = 108.

Aspects (negative) that needed to be improved included: (a) time constraints, meaning that students needed more time to participate in the classroom activities (38.7%); and (b) overwhelming information, meaning that too much information was given by the teachers (27.4%). The third most negative aspect was students' preparation, meaning that students needed to prepare before the class (19.4%). These results indicated that students needed more time in class to complete activities, to prepare for the class, and to understand the provided information. Students' opinions on choice of instruction they preferred in the future (section 4) are reported in Table 8.

Table 8

Summary of Students' (both groups) Opinions on Choices of Instruction They Prefer in the Future from Section 4 of the Attitude Scale

Instructional Approach Selected	Reasons	%
Constructivist (73.3%)	More student involvement	46.2
	Increase students' motivation	19.2
	Easier to understand concept	17.3
	Building students' foundation	9.6
	More fun in class	7.7
Traditional (21.3%)	More students' familiarity	54.0
	Easier approach	26.0
	Less student preparation	20.0
Both approaches (5.4%)	More student involvement	50.0
	Better teacher helpfulness	25.0
	Better experiences	25.0

Note. N = 108.

When students in both groups had an opportunity to choose an instructional approach that they want to be given in the future, 73% of the students selected the constructivist instructional approach. The major reasons included (a) a better chance to participate, (b) more motivation, and (c) greater understanding of concepts. However, some students believed that mixing both approaches together would be beneficial.

Based on the data presented in tables 5, 6, 7 and 8, there was strong evidence that students preferred constructivist instruction to traditional instruction. They were more receptive of the constructivist instruction, compared to the traditional instruction.

Discussion of Findings Relative to Student Achievements

Previous researchers of a constructivist instructional approach (Saigo, 1999; White, 1999) concluded that the constructivist model has been found to slightly influence students' achievement in a positive way. The constructivist model is capable of getting students more involved in learning and is an approach that students prefer. The findings in this study appear to parallel White and Saigo's research. Generally, students in this study participated more in the classroom activities and gained in content knowledge when a constructivist approach was used as identified by the opinions of students provided in the attitude scale.

However, not all previous studies agree. In a research study that closely paralleled this study, Makanong (2000) reported no significant difference in achievement between students in the two treatment groups. An additional point of agreement between this research study and another similar study (Gatlin, 1998) was that students' scores of those who received the constructivist approach showed a slight decrease on the delayed posttests, while students taught using the traditional approach showed a greater decrease. Students who received the constructivist instructional approach had higher retention over time. It can be said that students taught by traditional means, who rely on memorization to pass tests, over time often do not remember much of the information learned. Students exposed to conceptual teaching and who learn the main ideas process and remember information with better understanding over time (Kyle, 1984).

Although similarities were found between this study and other studies, they were in different fields. This study was in the field of vocational education, while other studies were in science and math. However, this could confirm that the concept of constructivist theory has influence across other fields of study. Among those studies, researchers found differing results. In some studies, no statistically significant difference was found between the mean scores of the sample's posttests in the two treatments groups. In others, there was a statistically significant difference for the sample's posttests where the students receiving the traditional pedagogy scored higher. The student achievement results for this research study parallels the first direction.

In relation to students' attitudes, White (1999) found no significant changes in attitudes over the course of the semester for students given constructivist vs. traditional instruction. There was a contrast between this study and White's study. The findings in this research study show that students preferred the constructivist instruction to the traditional instruction. When students in this study had an opportunity to select the instructional approach they preferred in the future, three out of four students indicated the constructivist instructional approach. The reasons why they selected the constructivist instruction were because of more involvement, motivation, and understanding of concepts.

Conclusions and Implications

Even though there is no significant difference for the constructivist instruction over traditional instruction, the students still preferred the constructivist approach by a 4 to 1 ratio. Students had a positive attitude toward the constructivist process in the classroom, and toward their teacher's role. Moreover, the results of this study show that in this setting, constructivist instruction is at least as good as the traditional approach. This is surprising because, given equal time on task for both methods, we would expect the more rigid and structured traditional approach to be superior in terms of posttest scores. For these reasons an argument can be made that constructivist instruction may be of value for teaching technical subjects in similar institutions in Thailand.

More research is needed in order to fully answer the many questions pertaining to the short- and long-term effects of constructivist instruction in Thai vocational education. Further studies in which the participating teacher is an expert constructivist teacher would provide additional data on the effect of full implementation of constructivist instruction on student achievement.

In addition, a long-term study is needed to determine the effectiveness of constructivist instruction. At least a semester would be a proper time to determine if there are any effects of constructivist instruction on student achievement. With more time, students will have an opportunity to get involved in and get used to the constructivist approach to instruction. The results of a longer study will also be useful to Thai teachers to learn and practice constructivist methods.

The sample in this study showed a lack of representation in gender with only eight of the 108 students that participated being female. The male to female ratio in this study is typical in Thai vocational education. Additional research is needed to determine if there is a difference between how male and female students in Thailand respond to different teaching techniques.

Thai students' opinion on the quality of instruction, instructor, and material and equipment were positive toward the constructivist approach. This could be a result of the student engaging in and showing interest in a new learning method (constructivism) more than being a result of the constructivist teaching method.

Additionally, when students were asked to choose an instructional approach they wanted to be given in the future, three out of four students selected the constructivist instructional approach. An argument can be made that the constructivist approach is at least as effective as the traditional approach. It can be implied that since students enjoyed the constructivist approach to teaching that if a more qualified teacher was administering the process, students would benefit more from the instruction. It is also important that the students get to practice these methods, starting at a young age. This will make them confident in searching for their own knowledge and will make them learn how to ask questions that will give them valuable information. Hopefully, it can also lead to students learning to take responsibility for their own work. However, the teacher still plays an important role here. It's not just about leaving it up to the students to do all the work, the teacher also must take responsibility.

Qualitative studies that examine the complex student learning styles and cultural context need to be pursued. A strong qualitative component would have contributed additional data for the interpretation of the quantitative data in this study. A combination of qualitative and quantitative methods could enhance overall learning and understanding of students.

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