IDEAS

1. Implementing a Dual System of Technical Education in Egypt

by Mohamed N. Abou-Zeid, Rudolf K. E. Bode, and Ali Sayed

The cooperation between the Arab Republic of Egypt and the Federal Republic of Germany dates back many decades. Since the 1950s, both partners have cooperated in the field of technical education and vocational training. Such cooperation took place mainly in the form of German assistance and support as represented by the German Foundation for Technical Cooperation (GTZ). The overall goal was to improve the performance and enhance productivity in those sectors.

Since 1991, Egypt has initiated a strict program of economic reform. The reform aims at transforming the economy from a state-controlled economy to an open market economy. This reform is characterized by economic mobility, privatization, and modernization. As expected, one aspect of the reform is the upgrading of human resources in terms of improvement of education in technical fields.

Under these economic parameters, in 1991 a new dimension was added to the already-existing Egyptian-German cooperation. During the discussions held between President Mubarak of Egypt and Chancellor Kohl of Germany, further cooperation in technical education and vocational training was stressed. In light of this, the German side offered assistance to Egypt in its economic endeavors by introducing the German experience of the dual system of technical vocational training. Later, a letter of intent was signed followed by a wide-scale feasibility study that took place from 1992 to 1995 in preparation for actual implementation.

Both the German and Egyptian parties agreed to implement the dual system in its first phase in the form of pilot projects in new, growing communities in Egypt. The selected cities were Tenth of Ramadan, Sixth of October, and Sadat City; all of which have strong industrial clustering and lie within 30 to 100 km (20 to 60 miles) from the center of the Egyptian capitol Cairo.

The existing education system in Egypt is comprised of five years of primary school and three years of preparatory school. Then, the trainee can either attend a general/technical secondary school, a vocational secondary school, or join the workforce. If one of the school options is completed successfully, the student can go to a university or a technical high institute or join the workforce. Out of a population of 66 million (1996 estimate), approximately 13 million pupils receive an education under the above-described educational system. Of this number, 1.5 million are enrolled under technical education (Country Monograph, 1995). Country Monograph (1995) and Stockman and Leicht (1997) provide more information regarding the general system of education in Egypt.

Dual System of Technical Education

The dual system of education refers to an educational system that emphasizes both theoretical and practical education. Although this approach is quite well known and implemented in many forms, few countries have well-structured and managed systems. Centuries ago, Germany adopted a dual system of education that has since undergone several modifications to cope with changes in society and meet the demand of the market. As of today, the system represents an essential cornerstone in German technical education with millions of students enrolled under its umbrella.

Similar to the German system, the dual system implemented in Egypt had to establish a strong, vital partnership between the technical school and the factory, that is, between the theoretical teaching delivered in school and practical experience delivered in the factory. This is reflected in an education scheme in which a student spends two days per week in the technical school, mainly acquiring theoretical knowledge, together with four days per week in the factory, acquiring practical experience pertinent to his or her profession. Industry is, on the other hand, interested in an education that is a good source for future well-trained technical workers. Therefore, the factory bears a small portion of the student's educational expenses as well as providing students with a monthly stipend as an incentive.

The newly implemented dual education system in Egypt is characterized by the following:

- Emphasizing professions of significant importance to the Egyptian economy that meet the demand of industry.
- Being trade-oriented in the sense that both theoretical and practical education are aiming side by side to enhance students' knowledge in the selected profession.
- Participating in the upgrading of education through enhancement of laboratory facilities, refining instructors' knowledge and qualifications and introducing advanced pedagogic methods.

Implementation Phase

The implementation process was characterized by two phases: the preparatory phase and the on-ground implementation phase. The preparatory phase (1992-1994) started after the preliminary agreement between the two heads of State and the signing of the letter of intent between the two governments in 1992. Several fact-finding and feasibility missions from Germany and Egypt worked together to acquire data and formulate the specific goals of the project. As a result, it was agreed to initiate the project through three pilot projects in three new communities dominated by the private sector.

The on-ground implementation phase involved the formation of a steering committee for the project, followed by the formation of the project policy implementation unit in 1993 and a German advisory team in March 1994. The first pilot project was implemented in the Tenth of Ramadan city, admitting a first batch of 300 trainees in 1995. A year later, the project was also implemented in Sixth of October city and Sadat City. As shown later, the project has continued to expand in other areas covering more vocations.

When comparing the newly implemented technical education system with the conventional system, we can observe the following:

- Students enrolled in the dual system have approximately double practical training hours than students of the conventional system. Often, the students deal with modern equipment in the factories that may not be present within school premises.
- Students enrolled in the dual system have only 30% less theoretical lesson hours than students of the conventional system. This was possible through modernization of curricula and the presentation of some of the theoretical background needed during the practical lessons/training.
- The students of the dual system have good exposure and experience with industry, securing jobs after graduation. This is not the case for the graduates of the conventional system.

Strategic Factors Influencing the Egyptian Dual System

The development of a strategy involving significant changes in the current Egyptian educational system mandates a consideration of the factors that have a major impact on the process. Major factors discussed herein are the overall goal, the positive elements supporting the process (referred to as supporters or pros), and the negative elements resisting the process (referred to as obstacles or cons).

Overall Goal: The overall goal, as agreed upon by partners in the Mubarak-Kohl project, is "The introduction and promotion of a dual technical education and training system according to the needs of the Egyptian society which serves the Egyptian economy with adequate number of skilled workers."

Supporters (Pros): The major elements that support the newly introduced system are:

- Existing liberalization and privatization of economy adopted by the government and supported by the people.
- Overall interest of a large economic sector, mainly the private sector, in the dual system of education and their willingness to bear a portion of its financial burden.
- Establishment of new cities/communities with relatively large industrial clusters, having an investors association in each that looks after the welfare of its member companies.
- Lack of satisfaction of the currently provided technical education service in the country and the general interest in upgrading and/or change.
- Acceptance of Mubarak-Kohl project by the public in Egypt as part of the general acceptance of cooperation with Germany.

Obstacles (Cons): The major obstacles of the newly introduced system that need to be overcome are:

- Partial lack of cooperation between ministries and governmental institutions involved in the project.
- Complicated distribution of responsibilities between private and governmental sectors contributing to the project in terms of responsibilities of the school and the factory.
- Presence of resisting currents from conventional educational systems that oppose upcoming changes.
- Occasional difficulty in allocating necessary funds to secure proper budget for a high-quality education.

Project Initiation

To initiate the project, a supreme committee, headed by the Egyptian Minister of Education, was formed. Members of this committee include key figures of the industry, education experts, and high-ranking representatives of ministries concerned with the project.

A Project Policy Implementation Unit (PPIU) was set up next to a ministerial level that reports to the supreme committee and is directly under the control of the Minister of Education. The PPIU focuses on system planning and concept development and supports the supreme committee during the introduction of a new cooperative system. The PPIU pursues development tasks in the following fields:

- Securing the necessary funds for the success of the project.
- Establishing in-company vocational training in selected regions and sectors.
- Founding Regional Units of Dual System (RUDS) in designated pilot project areas.
- Launching in-school dual vocational education and training in selected regions or sectors.

Some thought has been given to establishing the PPIU at the national level to prepare the ground for decisions of the Egyptian institutions responsible for technical education and vocational training. Also, the PPIU will promote cooperation between different parties and will not be limited to the Ministry of Education. The central task of the PPIU in its new form will be to provide advice regarding legal, financial, and organizational frameworks needed for the introduction of the system as well as to provide proposals for the further promotion and diffusion of the project.

In 1995, a pilot project was initiated in the Tenth of Ramadan city, an industrial community that lies approximately 60 km (40 miles) from the capital, Cairo. As a start, the trades of industrial mechanics, electronics, and ready-made garments were selected based on the demand reflected by industry in those communities. In other pilot projects that followed, it was often the case that an extensive survey was carried out to explore the demand of industry to vocational training and the potential extent of cooperation with the project in these communities. A good example for those studies is provided by the work of Stockman and Leicht (1997) prior to the introduction of the dual system in the Sixth of October city. A major outcome of such studies is to predict future demand of the industry in the community, thus facilitating the selection of future trades of interest and feasibility.

Project Growth

Since its start, the project has undergone significant growth as shown by the data in Table 1 and presented in Figures 1 to 3. This is evidenced by the increase in pilot projects taking place throughout the country and the increase in number of personnel involved in the various aspects of the project (Bode & Sayed, 1997; Mubarak-Kohl Project Progress, 1997). For example, in 1995, there were only two schools participating in the project compared to 12 in 1997. Such an increase must be looked at not only in terms of absolute magnitude but also in terms of ratio. The increase in number of dual system schools came in part as a result of the increase in the number of communities (cities) where the project was implemented (1 in 1995 compared to 10 in

Table 1

Characteristic Data of Project from 1995 to 1997

Criteria	1995	1996	1997
Cities involved	1	7	10
Schools involved	2	8	10
Vocations	3	5	7
Students	320	1350	2300
Instructors	36	180	260
Factories	65	210	390
Instructors trained in Germany	14	58	82
Instructors trained in Egypt	34	194	280
Experts involved (long & short term)	12	38	63

Figure 1. **Progress in numbers of cities, schools, and vocations adopted by the project.**

Figure 2. **Progress in numbers of personnel involved in the project.**

Figure 3. **Progress in upgrading of teachers and trainers and the experts involved in project**

1997) as well as the increase in the number of vocations considered (3 vocations in 1995 compared to 7 vocations in 1997).

As a result of the previously mentioned increase, the number of dual-system students, in-school teachers, and in-factory trainers have all increased. For example, the number of students has increased from 320 students in 1995 to 2,300 students in 1997. Also, the number of teachers has increased from 36 in 1995 to 260 in 1997. Again, such an increase may not be sizeable when compared with the overall number of students and teachers in Egypt, but the rate of increase is very significant.

Clearly, the increase in numbers of teachers and students is not the sole indicator that reflects project development since it is basically a quantitative one. Table 1 shows that the increase in numbers has been accompanied by an increase of upgrading courses that took place either locally or abroad as well as the increase in the number of short-term and long-term experts participating in the project. It can also be noticed that the increase in the number of upgrading courses is not a simple increase resulting from the increase in the number of students or so. Rather, the ratio with respect to the number of teachers and trainers has in itself increased, leading to a more significant increase.

Future Development

The future plan of the project concentrates on strengthening the dual system in Egypt through:

- Expanding the project through the existing pilot projects, which means stronger participation of the industry in those communities.
- Executing a well-planned "diffusion process" to other communities where implementation is feasible.
- Including other trades under the umbrella of the project, such as those trades related to construction and tourism. This may involve cooperation with other agencies/bodies such as the Ministry of Housing and Construction, the building and construction federation, and the Ministry of Tourism.
- Expanding the PPIU role to cover the new disciplines of vocation training, which mandates involvement of staff from bodies other than the

Ministry of Education.

- Working with authorities in Egypt to issue a separate law that regulates vocational training that is separate from the current labor law. This is needed due to the special nature of the vocational training process (PPIU, 1997).

References

Bode, R., & Sayed, A. (1997, October). *Solving the workforce needs in the Arab Republic of Egypt: An Egyptian-German partnership*. Paper presented at the 30th annual conference of the National Association for Industrial Technology, Atlanta, GA.

Country monograph. (1995). Cairo, Egypt: German Foundation for Technical Cooperation.

Mubarak-Kohl Project progress. (1997, July). *Mubarak-Kohl Project Newsletter, 2*, 1–12.

Project Policy Implementation Unit. (1997, November). *Strategic action plan: Mubarak-Kohl initiative*. Cairo, Egypt: Author.

Stockman, R., & Leicht, R. (1997). *Implementing a dual vocational system in Egypt*. Eschborn, Germany: German Foundation for Technical Cooperation.

Dr. Mohamed N. Abou-Zeid is an Engineering Assistant Professor at the American University of Cairo and member of the Mubarak-Kohl Project for Technical Education in Egypt. Dr. Rudolf K.E. Bode is the German Chief Advisor of the Mubarak-Kohl Project for Technical Education in Egypt. Eng. Ali A. Sayed is the Head of the Project Policy Implementation Unit of the Mubarak-Kohl Project for Technical Education and the Advisor of the Egyptian Minister of Education for International Affairs.

2. Does the Recent Literature in Technology Education Reveal the Profession's Direction?

by Jane A. Liedtke

A review of the research literature in technology education conducted by Zuga (1994) included dissertations and research literature published between 1987 and 1993 that focused on technology education and technology teacher education. She summarized the research as follows:

> - 50 percent of the research is devoted to curriculum status, development, and change.
> - 63 percent focuses on secondary education
> - 53 percent studies teachers/teacher educators. (p. ix)

Under what Zuga (1994) described as "Unfulfilled Promises," a key statement was made:

> A concern and goal of the field has been to establish a discipline of technology education and with that to fulfill the goal of creating technological literacy. What is interesting is that no research has been done to this end. No discipline was created and none may ever be able to be created given the nature of people's involvement and use of technology. Disciplines are formed when communities of scholars working together can agree that such a discipline exists. Technology educators are but a small part of the community of scholars who are technologists. (p. 66)

Publishing is one activity indicative of a community of scholars. Thus, there should be a direct relationship between what research is conducted and what articles are appearing in our journals and as ERIC documents. It may come as no surprise that this relationship is a very weak one. Given the size of our profession, little research is being conducted and even less research is being published. Those who do publish are writing about those subjects that tend to be the current "hot topic" (the Internet, robotics, design briefs, etc.) and less about the "heavy issues" in technology education (technology education as a discipline, technological literacy, pedagogy for and learning of technology, attitudes, external groups to the profession such as parents and school administrators, etc.).

Status of literature in technology education. Literature on technology education has been narrowly confined to a few journals and ERIC documents. A search of the library databases found that in ERIC many documents (mostly curriculum materials) are catalogued under technology education descriptors. However, in searching databases for periodical literature and subject searches for books, the descriptor technology education (or combinations, technology with education, technology and education, etc.) yielded a large number of articles and books with little to no relationship with what our profession would view as technology education. Because the databases are using descriptors that are not narrowly defined or specific to our profession, our literature is lost to the outside world seeking to find information using accepted library search tools. This does not mean that our literature is not "out there" to be found. What it means is that it is mostly confined to ERIC and only those library databases that search a very broad range of journals (including those within our field).

What journals are related to our profession? Many journals and magazines serve the broad spectrum of topic areas related to technology education. Brauchle, Liedtke, and Loepp contributed a list of more than 100 technology-related journals that are well suited to the field. It is included in *Preparing Manuscripts for Professional Publication in Technology Education* (Brauchle & Liedtke, 1997). Domestic and international professional associations as well as trade and technical organizations provide a wealth of resources for technology teachers. For the purpose of this article, five publications were reviewed that are most specific to technology education and where most of the literature consistent with the philosophy of technology education is found.

What are the key journals in technology education? *The Technology Teacher* (ITEA), the *Journal of Technology Education* (ITEA), the *Journal of Industrial Teacher Education* (NAITTE), the *Journal of Technological Studies* (EPT), and *TIES* magazine are considered to be the main sources of literature in the field. Classroom teachers of technology education and technology teacher educators review these sources for information on curriculum and research. In addition, the annual Yearbooks of the Council on Technology Teacher Education are considered to be leading sources of information on their respective subjects. Magazines such as *Tech Directions* are popular among teachers due to the nature of their distribution.

What are we reading in the journals? A review of the five publications identified was conducted for the purpose of this article. The most recent 12 issues (as of Winter 1996) for each publication were examined with the exception of the *Journal of Technology Education*, where nine issues were reviewed. Three hundred and thirty-two articles were categorized by the classifications given below:

- Philosophy of Technology Education (such as technology education as a discipline, standards for technology education, technological literacy, history).
- Curriculum and Instruction Information (such as program design, content and structure, mathematics-science-technology interface, delivery, interdisciplinary approaches, outstanding or model programs).
- Facilities (instructional laboratories and equipment).
- Technological Systems (such as communication, manufacturing, construction, transportation, biorelated technology systems).
- Student Activities (student-centered activities and "how to do *xyz*" in the classroom with students, student organizations).
- Research (articles about conducting research versus those based on research).
- Professional Issues (leadership, mentoring, recruitment, minorities).
- General Interest (the Internet, grant writing, partnerships, resources).
- Others (articles that are not technology education).

Table 1 provides a sense of what has been published in these publications and thus what represents the majority of our current literature. Technology education articles represented 67% of that which was published therein. Of the 222 technology education articles, 22.5% were related to technological systems and the curriculum organizers of communication, manufacturing, construction, transportation, and biorelated technology systems. Many articles within this classification were about new technological developments and applications in technology education. Some of these articles related exciting technology content that could easily be adapted to classroom instruction by competent technology teachers. However, the classification of student activities only represented 3.6% of the articles. The perception that *The Technology Teacher* and *TIES* magazine have a lot of "how to" articles for classroom teachers is not the case. These two publications contain the largest number of articles that are focused on technology systems.

Curriculum and instruction information (21% of the articles) was a major area within the publications. This is consistent with Zuga's (1994) review of the research literature which showed that 50% of the research conducted was related to curriculum development, status, and change. More of the curriculum research conducted should be published. The curriculum articles that are published are dispersed evenly across the five publications.

The third-ranked classification was that of general interest, with 41 articles (18%). These included articles related to tech-prep, school-to-work topics, technology education in other countries, and the like. Professional issues ranked fourth with 38 articles (17%). This classification included articles on minority issues and recruitment, leadership, teacher preparation, in-service activities, and similar topics. A large portion of this literature appeared in

Table 1

Number of Articles Published in Five Publications Based on Classifications Given

Classification	TTT	JTE	JTS	JITE	TIES	Totals	
	Publication*						
Philos. of T. E.	12	5	9	3	0	29	
Curric. & instruc.	10	11	12	5	9	47	
Facilities	2	0	0	0	6	8	
Technological sys.	17	0	6	0	27	50	
Student act.	7	0	0	0	1	8	
Research articles	1	0	0	0	0	1	
Prof. issues	6	9	19	4	0	38	
General interest	12	11	6	4	8	41	Subtotal 220
Other (not T. E.)	0	5	67	38	0	110	
Totals	67	41	119	54	51	332	

Journal and magazine issues examined:

The Technology Teacher	
October 1994–February 1996	n = 12
Journal of Technology Education	
Fall 1990–Fall 1995	n = 9
Journal of Technology Studies	
Summer/Fall 1988–Winter/Spring, 1995	n = 12
Journal of Industrial Teacher Education	
Vol. 29 #4 (1992)–Vol. 32 #3 (1995)	n = 12
Ties magazine	
March 1991–February 1995	n = 12

two journals: *The Journal of Technology Studies* (which had the largest number of professional issues presented—19) and *The Journal of Technology Education* (which had the second highest number of professional issues presented—9). This is consistent with the leadership and professional development mission of Epsilon Pi Tau as an international honorary.

Philosophical issues in technology education, standards (Technology for All Americans), industrial arts versus technology education, and technological literacy ranked fifth with 29 articles (13%). The publishing of these topics was primarily in *The Technology Teacher* and *The Journal of Technology Studies*.

Articles that met the criteria of "other" were primarily within the areas of vocational education, trade and industrial education, and industrial technology. *The Journal of Industrial Teacher Education* had the largest number of vocational and trade and industrial education articles. *The Journal of Technology Studies* had the largest number of industrial technology articles most reflective of industrial management degree program efforts among the five publications reviewed. The *Journal of Industrial Technology,* which was not reviewed, would have exceeded the *Journal of Technology Studies* with the percentage of industrial technology articles if it had been included.

The CTTE Yearbooks, considered to be valuable literature by our profession, have over the same period of time been devoted to communication in technology education (1990), technological literacy (1991), transportation in technology education (1992), manufacturing in technology education (1993), construction in technology education (1994), and foundations of technology education (1995). Of these six yearbooks, 75% of the content is devoted to curriculum and technological systems with 25% focused on philosophical issues, historical perspectives, and technological literacy.

How much of the focus is on classroom teachers (K-12) versus teacher preparation? *The Technology Teacher* and *TIES* magazine are classroom teacher oriented. Of the 67 articles published in *The Technology Teacher,* 34 clearly target classroom teachers with many of the philosophical, general interest, and professional issues articles applicable to a wide range of professionals. *TIES* is targeted to a larger extent toward the classroom teacher. Forty-three of the 51 articles were classroom teacher (K-12) focused. This accounts for 84% of the articles published.

Very little was written on technology teacher preparation. Two prime articles were on teacher preparation curriculum and college student burnout. One article was concerned with the NCATE accreditation process. One could suggest that the technological systems and curriculum topics would relate to teacher education in terms of content that would be taught once students entered the profession as classroom teachers. In recent years there is little literature focusing on the needs of college students, college student organizations, and the curriculum for technology teacher preparation. The CTTE Yearbooks, while focusing on the public schools, provide outstanding reference materials for teacher preparation courses. One chapter was devoted to teacher education in each of the yearbooks for the four curriculum organizers (communication, construction, manufacturing, and transportation) and the yearbook on the foundations of technology education. Despite this, there remains a great need for research and articles devoted to issues of teacher preparation and certification.

How much of the focus is on guidance counselors, principals, school district personnel, parents, business/industry, government, and other gatekeepers? Is this a missing element in our publications? Two articles were on school-to-work transitions (which relate to business/industry as a recipient of high school graduates). Other than those two articles, there was not one article that focused on this group of important people in the educational setting. Here is a need waiting to be met! The profession needs assistance in linking with these key individuals. Classroom teachers and teacher educators need models in the literature that provide strategies for working with these groups to ensure a positive future for technology education. Articles targeting publications within counseling and school administration professional associations are also essential to creating a broad range of literature on technology education.

What about the science and mathematics education journals? Are we publishing our efforts at integrating mathematics, science, and technology through curriculum projects in these publications? Only three integration articles appeared in the five technology education publications reviewed. With several major national efforts ongoing in our profession to integrate mathematics, science, and technology, classroom teachers and teacher educators seem eager (as evidenced by the popularity of such sessions at the ITEA conferences) to learn more about the successes of these curriculum development efforts.

Is quality the issue or a problem? Having reviewed as a member of the editorial review boards for all but one of the five key publications, I can honestly say that what is submitted by members of our profession is alarming. What is published, while much better than what is submitted, tends to lack depth or has not been prepared based on extensive research support. That is not to say that there are not wonderful, useful articles in our journals. It is to point out that much of what we do could be better.

It is more likely a reflection on our profession and our background, interests, and personal attributes. Individuals have selected our field over other professions because they prefer to work with technology. They are often not interested in writing and publishing. This creates a strategic dilemma. Individuals need to conduct research and publish—few do as Zuga (1994) pointed out in her research review. Publishing is an expectation of faculty at higher education institutions. People who are not successful with their first attempt at publishing often do not resubmit their publication and may not be motivated to publish in the future. Alas, a small group of individuals become successful at publishing. Something must be done. We can intuitively wonder: What good ideas and information are we missing out on that people have rolling around in their heads?

Modeling may also be an issue. People tend to model and emulate what exists in the literature regarding writing style, format, and, in some instances, topics (acceptable to the journal).

What are our focal points for future action?

Some observations:

- Few people publish.
- Most research conducted has not been published.
- Technology education as a discipline must be clearly defined, disseminated, and operationalized.
- Lack of research base in most litera ture or lack of depth on the topic(s) is evident.
- Little to no theoretical basis for our research and thus the literature that stems from the research lacks the rigor of other disciplines.
- Lack of experimental research (controlled research investigations and appropriate data analyses).
- Lack of literature on technology teacher education, mathematics/ science/ technology interface and interdisciplinary approaches, in-service programs, and certification issues.
- Little attention to diversity, minority recruiting, and retention.
- Counselors, parents, school administrators, and business/industry and their relationship to technology education have received no attention in our journals.

Some possible directions:

- Rewards and incentives for publishing.
- Increased opportunities to publish refereed articles.
- Mentorships for publishing (linking young professionals with seasoned writers).
- Promote interdisciplinary cooperation and study of technology to facilitate the acceptance of a discipline for the study of technology.
- Require doctoral research for the PhD degree to have a theoretical base and include experimental methodologies.
- Require publication from dissertations as a part of doctoral degrees.
- Expect publication as a result of grant activity.
- Provide increased funding for research activity (expanding our reach to other types of funding agencies).
- Link with colleagues outside our field to prepare and publish articles.
- Involve counselors, parents, and school administrators in our professional associations.
- Provide journal subscriptions to other professionals at our institutions.
- Encourage minorities and women to publish and provide support systems to enable this to occur.
- Seek funding for journals to support their publication costs, thus enabling refereed publications to be a reasonable length.

How can practitioners help? As technology educators, we have the opportunity to share our successful classroom experiences, results of master's and doctoral research, and perspectives on issues facing the profession. Engaging in such activity creates the environment conducive to a community of scholars. Moreover, it assists others in recognizing technology education as a discipline. It is imperative that we assist those who prepare technology education and technology-related journals in delivering publications that meet the needs of in-service and preservice teachers, teacher educators, school administrators, parents, and, ultimately, students. Beyond that, we must connect to those who are on our periphery. To achieve this end, we must all try to publish the fruits of our labor and be diligent about sharing beyond these mainstream publications.

Journal editors are eager to link less experienced writers with those who can serve as mentors. This process assists the novice in publishing and thus increases the pool of individuals contributing to the base of literature that serves the profession.

References

Brauchle, P., & Liedtke, J. (Eds.). (1997). *Preparing manuscripts for professional publication in technology education* (CTTE Monograph 15). Reston, VA: Council on Technology Teacher Education.

Zuga, K. (1994). *Implementing technology education: A review and synthesis of the research literature* (Information Series No. 356). Columbus, OH: ERIC Clearinghouse on Adult, Career, and Vocational Education.

Dr. Liedtke is a Professor in the Department of Industrial Technology at Illinois State University, Normal. She is currently on leave directing the ISU-CIPG Center for Corporate Training and Consulting, Beijing, China. She is a member of the Gamma Theta Chapter of Epsilon Pi Tau and has received the Honorary's Laureate Citation.

3. Extending the University's Reach with Technology

by Kurt H. Becker

Using technology has always been an integral part of society. Throughout history, the available technologies of the time dictated the direction of human existence. But, technological developments have had a limited impact on education and have done little to change limited access, low quality, and low productivity and to improve the primitive technological tools used by teachers.

Our stance toward technology in education—our impressions of what it is, what it is good for, and how we should think about it—has long been a problem. Many of the failures of the past stem from this problem: The films we expected to revolutionize teaching in the 1920s, the radio broadcasts that would bring the world into every school room in the 1930s, the "new media" of the 1950s and 1960s (television, Super-8 film, language laboratories), the passion for programmed instruction of the

1960s, the novelties of distance education and dial-access audio and video in the 1970s and 1980s, and now virtual schools in the 1990s—in all these cases, we started with enormous expectations about what a particular set of technological devices, used in a particular way, might be able to accomplish. While there were a few successes (the overhead projector that rapidly spread into most of the classrooms in America, the wide-ranging dissemination of VCRs, the power of distance education and "open university" approaches to extend higher education to new audiences), there were certainly failures and criticisms such as the machines that were used once and consigned to the closet and the devices that teachers used only once a year because they were too complex. Such teacher tools had little or no effect upon the existing paradigm, and teachers could take them or leave them.

The debate over the impact that technology is having on education and what impact it will have in the future continues today. Some believe that technology is so powerful that it can effectively eliminate schools altogether. Others think that this is a basically flawed and alien ideathat is contrary to our most central notions of what a good society is.

Perhaps the primary thing to bear in mind about the interaction of technology and schooling is that the process has never resulted in anything close to what educators hoped and assumed it would do. Rather, using technology became associated with economics (employment prospects for graduates, based on the "skills needed for the information age") and with community pride ("Our school has six networked PC labs!"). In these cases, the decision makers failed to examine a central underlying assumption: We only think of education and schools as means for application of computers, software, networks, and associated technologies.

The Changes

A paradigm shift is underway. And new technological tools for learners are significantly and simultaneously moving toward the accomplishment of three major goals of education reform: better access, better quality, and better productivity (Davis, 1996).

Achieving Access

For a variety of reasons, large segments of our society have limited access to the means for learning. For many time is a factor. For others it is a matter of being out of reach of a campus.

Lack of access can also mean that a neighboring college doesn't teach what some need to learn or that the available curriculum is otherwise undesirable. Scores of students physically attending college are routinely forced to add an additional semester or school year to their college tenure simply because they couldn't enroll in the classes they needed or wanted due to scheduling, full classes, lack of course offerings, and more.

To facilitate better access there must be a change in the existing system. Converting from a bricks and mortar, labor-intensive system to one that gives learners information technology tools will require massive capital to build infrastructure, retrain personnel, and create new learning materials. Schools must yield their role as the primary providers of content and shift to a role of providing means and services for students to develop learning skills. The high speed network infrastructure that is under construction throughout the world and high speed fiber optic data lines in our homes and offices will help facilitate this access. This will facilitate an "anything, anytime, anywhere" paradigm (Wittmann, 1994), which may lead to electronic educational communities with minimum barriers of distance, time, race, age, gender, and appearance. It is likely to promote collaboration and increase the quality of education.

Increased access means learners can sign on to a course and begin taking it the minute they realize they need it. It means they can pursue aspects of a subject that are relevant to their immediate need and demonstrate mastery by applying what was learned in a meaningful context. It means learners progress through the components of a course at an individual pace rather than in lockstep fashion. This will result in a changing relationship between school and industry since industry demands the use and knowledge of current technologies. As technology becomes more commonplace, it will be used in all sectors of life, and this will directly alter students' learning needs and abilities.

A curriculum addressing this need may cost millions to produce, but once completed, the costs to manufacture, distribute, and update it are moderate. Such a curriculum could stand alone or be used in conjunction with commentary and individualized lesson plans from an online mentor. The curriculum could be partially or entirely completed at home or at work, and at a pace that suits each individual learner.

Access to education primarily means giving up the notion that a classroom is a place of assembly at a single place and time. It also means and requires the revolutionary step of putting learners in charge of their learning process. The conventional classroom lecture takes place in a cloistered set of buildings with rows of students facing the teacher, who has prepared the lesson he or she thinks is important. It creates an environment that tends to ignore higher order learning skills such as creativity, independent thought, inquiry, research, leadership, and innovation. Many experts will agree that the classroom is one of the few places of human activity that someone who had slept for 200 years could wake up and return and still feel comfortable.

Conversely, the learner who is his or her own teacher has far greater access to learning through the convergence of computers, telecommunications, and traditional classroom media. This, in turn, can increase quality and productivity.

Achieving Quality

Looking at today's education, change is inevitable. Technological changes will have an effect on the entire teaching system. Technology is providing new tools of thought and action that graduates *must* be able to use in order to compete on a global basis.

A better, more affordable, more widely used information technology system must continue to be developed. The library is one place to proceed with these changes. Change will bring the advent of the digital library, which in turn will create regional and national libraries. This information will be available to learners on-line, minimizing search times. These libraries will also deliver multimedia and electronic (digital) textbooks, which will give learners text, pictures, video, and sound. All of this can take place in less space because of digital technology. Libraries will be easily accessable and open themselves to interaction with the learner.

Currently, multimedia technologies are emerging that provide new ways for education to do business. They enable education decision makers to make dramatic changes in delivery, evaluation, and so forth.

What are the emerging components of multimedia?

1. Library services available over campus networks.
2. Conceptual designs for electronic libraries.
3. Development of permanent and portable multimedia delivery systems.
4. Effective use of all of the components of a digitized communications network (voice, video, and data).

Multischool classrooms on the Internet will soon begin to proliferate. Increasingly, sophisticated "search engines" make it easy for even an eight-year-old to become a sophisticated researcher and explorer, locating new information databases and exploring new curiosities on a daily basis. Providing a more learner-centered system will not change everything.

Some students will continue to want physical proximity to other students and teachers. Other learners will want only occasional support and guidance, and some will seek independent study and courses of quality. Many students will want customized learning programs comprised of individual courses, course components (modules), and short-term certificates. Today's learner is a lifelong learner. As colleges learn to exploit this opportunity, they will custom build and import the "courseware" to meet the individual needs of learners who enroll.

The use of telecommunication tools introduces new platforms for knowledge. Students can collect, manipulate, organize, analyze, evaluate, and reflect alone or in groups with divergent sources of knowledge and information worldwide. If a student wants to know what a "Communist" is, he or she can correspond with a teacher, student, or government minister in Cuba or China—a real flesh-and-blood Communist (Kerr, 1990a).

Telecommunication creates whole new audiences for the student. He or she must learn to analyze each audience and learn to communicate in a context-specific, coherent way. There will have to be changes in the way information is distributed and shared, and new strategies for storage are needed (Tennant, 1995). The use of technology to help learners access, search, and retrieve information is increasing at unprecedented rates. A major part of establishing learner access is the recognition that a teacher comes in many forms and through many pathways, some not yet invented.

Achieving Productivity

Information technology has generated dramatic cost-benefit gains in virtually every other sector of our economy: financial services, manufacturing, retail distribution, health care, entertainment, and government. Why, then, is our most vital segment, education, lagging so far behind?

There has been no incentive to change the local elementary school, and the community college has no real competition. Tenured faculty have little motivation to change their teaching methods as long as their classes are full and there is a demand for services. Many teachers are themselves resistant to technology and, consciously or unconsciously, terrified that it will displace them.

Administrators of traditional schools are beginning to realize that they will not have a captive market much longer. Technology-based companies, leveraged by inexpensive manufacturing and cheap distribution (e.g., the Internet) will increasingly turn out attractive and relatively inexpensive new ways to learn. New communities of learning are being created daily on the Web.

While encouraging innovation within the faculty, universities are highly resistant to change institutionally (Hawkins, 1992). What makes the transition inevitable is that educational productivity will continue to decline under the present system; costs continue to rise and access is increasingly denied. As educators, our choice will be to consciously move with change or be dragged along by it. Unless educators learn to work with the private sector to use technology, they may begin to disappear.

As we shift control and initiative from teacher to learner, the role of faculty member shifts to the facilitation of increasingly autonomous student practices. Curriculum design becomes the art of posing problems, introducing large questions and then facilitating work on them. The teacher shifts from lecturing to fomenting questions, doubts, and uncertainties; suggesting strategies of inquiry; and questioning the quality of reports and conclusions. This kind of work will require great sensitivity and dedication to individual learners (Kerr, 1990b).

There will also be teachers who lack heartbeats. There will be a variety of computer-generated video-sound-and-text-based experiences. Exciting new technologies such as virtual reality and multiuser simulated environments will challenge users to use abstract reasoning to navigate knowledge-intense environments and simulate physical tasks. Using this kind of technology, students can encounter real geography, history, science, language, or business problems by themselves or with other students scattered in space and time.

Serving as a successful mentor will require new teaching techniques in design, facilitation, and counseling. Students may be involved in facilitating learning experiences, such as the creation of an on-line conferencing process where students simulate a joint research term in a fictitious company. Students might publish their research findings in an on-line journal, offer critiques and questions about each other's findings, and be challenged by the faculty facilitator who plays the role of the business interest that commissioned the research.

The real value of any good technology is not that it will do things for us faster, better, and cheaper, but that it will make us better at what we do. Learning is innately and uniquely human. Digital tools will provide new levels of access, analysis, simulation, and synthesis that will generate increased learner participation in intellectual work. With these new capabilities, learners will not need teachers to teach them but rather to facilitate their learning skills, the development of their character, and their vision of the future. This will assist in achieving the educational goal of better access, better quality, and better productivity. However, there will be numerous issues with which those in education will be faced with since change does not occur without difficulties or challenges.

Some Issues Related to Change

1. As information technologies become digitally based, distinctions between voice, video, and data will blur, causing attention shifts to an information infrastructure. This will amplify the speed and accuracy with which information will be available to education and industry. The information technology industry will continue to adjust to the changes in education. These changes will be determined by economic factors, which include the dropping cost of technology hardware and developing multimedia for the home consumer market. These changes will increase market size, which in turn will decrease the ability for education to have partnerships with industry because the reduced prices of hardware will make it difficult to develop a win-win situation.

2. Higher education will become less important to vendors as the market expands into the home. Vendors will support the creation of high-end software that, in turn, will drive and stimulate sales of hardware and operating systems to support the software. Vendors will have a vested interest in developing multimedia applications that require more powerful, faster technology. This could result in education changing dramatically in the method of delivery to maintain its competitive market share of the existing student populations.

3. Digital technology will alter the lecture paradigm when we harness the energy of the networked virtual university and engage in collaborative instruction. Collaboration will involve more than one individual involved in course design and delivery, and students who actively participate in instruction. This will engage students and the school systems in active, meaningful competition for the digital age.

4. When designing an educational system, we can certainly predict how changing the process will send a more desirable message to learners. What we can't predict are the elements of design and delivery that rely on human character and individual motivation, and this human element remains crucial. Again, we should consider whether a well-rounded education is a function of teaching or of a learner making selections from a balanced curriculum.

Because of the capacity afforded by information technology to make learning more outcome oriented, opportunities for accelerated learning will multiply. As a new generation of learners becomes accustomed to deciding when to learn, what to learn, how to learn, and even how progress is to be certified, the need for human intervention in the process of learning will diminish to infrequent high-quality counseling and mentoring sessions. The inherent "learning machine" can be liberated.

References

Davis, E. (1996). *The future of education*. Available: http://www.wco.com/ ~mktentry/edfutur.html

Hawkins, B. (1992). Symposium panel discussion at the annual meeting of the Association of Instructional Technology in San Diego, CA.

Kerr, S. T. (1990a). *Alternative technologies as textbooks and the social imperatives of educational change*. Chicago: University of Chicago Press.

Kerr, S. T. (1990b). Technology: Education: Justice: Care. *Educational Technology, 30*(11), 7–12.

Tennant, R. (1995). Multimedia. *Syllabus, 9*(5), 30–36.

Wittmann, A. (1994). Infrastructure. *Network Computing, 5*(13), 28–30.

Dr. Becker is an Associate Professor in the Department of Industrial Technology and Education at Utah State University, Logan.

4. Creative Problem Solving: A Unique Aspect of Technology

by Andrew E. Schultz

Education is teaching people how to think. Training is teaching people how to behave within narrow specializations. We do both in our schools. This is as true of technology studies as it is in any other part of the school curriculum.

Our school system is charged with the responsibility for the development of cognitive skills in students. Basically, this means that students must be taught to use their most extraordinary feature, the brain, to ensure our survival and to improve our lives. We humans have been blessed with at least four cognitive gifts that have enabled us to conquer nature and recast our world. Only three of these gifts are evident in the core curriculum: (a) the ability to make sounds and symbols that convey meaning (or communications), (b) the penchant for quantification (or mathematics), and (c) the ability to observe objectively and make rational decisions about these observations (or science). The fourth gift, tool use, is the ability to make, modify, and wield tools in a productive fashion for the improvement of society. This fourth gift is not part of the core curriculum, but it should be. Without development of the fourth gift, skills in math, science, and language are just empty tricks, mere glib-tongued, sharp-brained sophistry. Ancient Greece and China, the pre-Columbian Incan, Mayan, and Aztec societies of South America, and the dark-age and medieval Europe are examples of some of the societies that failed to make full use of all four gifts to their ultimate detriment. That tool use is not a recognized integral partner in the core curriculum in America is as short sighted as the trivium was in the Middle Ages.

In secondary education today, teaching tool and equipment use is the province of technology education and, as such, it is where the melding of the core curriculum takes place. It is the ideal site for contextual learning to happen, and increasingly, our best teachers are realizing this. They are making the association that applied learning enriches the core curriculum by enabling students to stretch cognitive skills and actually synthesize new knowledge. It is also where real problem solving is taught and occurs.

But what makes technology education really unique is that both kinds of problem solving are taught. *Both kinds?* Yes, few people realize that there are actually two sorts of problem solving. Applying algorithms (or the application of known solutions to classes of existing, already solved problems) is commonly taught in our schools. Outside of an art class or a traditional shop program, however, creative problem solving (or how to solve unique or unsolvable problems) is rarely addressed. While capabilities in this second type of problem solving are never given curricular space to develop, these are the very abilities that may prove critical to our survival as a society and even as a species.

Applying algorithms has proven a rich source of techniques for the exploitation of the world's resources—our dominance of the world owes much to this way of thinking. At the same time, however, despite the impressive technological advances of the late 20th century, our collective capacities to deal with the global moral, economic, social, and environmental consequences of these advances are already bankrupt. These challenges are just the bills coming due today. The difficulties of the next century seem to expand exponentially with every scientific, technologic, and economic innovation, even as we fail to solve those problems facing us today. Ironically, these problems result from the very mastery of this vastly fruitful first kind of problem solving, applied algorithms. It is unlikely that the solutions to these kinds of endemic problems can come from the same technique of thinking that produced the problems in the first place. Rather, the solutions we desperately need are the kind of paradigm shifts that spring from the second kind of problem solving, creative problem solving.

Unfortunately, there is a large body of evidence which supports the beliefs that expertise in applying algorithms is developed at the expense of creativity and that as one masters a body of knowledge and its traditional organization, it is exceedingly difficult to slip outside of that organization and see it again in a new, reordered, and more meaningful manner. Rare are people such as Copernicus and Galileo, who were experts and yet able to recast their knowledge in a new, more meaningful fashion. More often, when one is schooled in a specialty and in how to organize and process information about that specialty, there's an almost inescapable tendency for one to see the rest of the world through that same prism of narrow expertise as well. In educational psychology terms, this is called functional fixity (Moates & Schumaker, 1980).

To illustrate functional fixity, consider the following story that the great Gestalt psychologist, Wolfgang Kohler, once wrote of his favorite chimpanzee, Atlas, and the puzzle he had posed to him. Kohler was studying primate problem solving at the time and had done this experiment several times prior to working with Atlas. He would suspend a basket of fruit from the top of a fairly spacious cage that also held an ape, several sturdy boxes, and a long stick. Most apes would try the stick first, but finding it too short, would puzzle for a while and then in a flash of what Kohler saw as "insight" use a box to stand on to get the fruit. Atlas, however, could not solve the problem. Kohler sat outside the cage taking notes while Atlas studied the fruit and the boxes. One hour passed. Two. Kohler grew increasingly worried about Atlas. He was the oldest ape, and he grew increasingly despondent, looking frequently at Kohler with pleading eyes. Finally, Kohler could stand it no more, and he entered the cage to reassure Atlas. Immediately on entering the cage, Atlas took Kohler by the hand, led him so that he was directly under the bunch of fruit, and then climbed Kohler until he could reach it. Kohler took this as an example of both his own and Atlas's inability to recast old familiar forms into new innovations or functional fixity (Moates & Schumaker, 1980).

These different types of problem solving are liked and relied on by different kinds of students, too. While business and industry report that they want people who are critical thinkers, team players, and problem solvers (Rogers, 1995), they are not thinking of the creative problem solvers. Business and industry want those with a knack for applying the heuristics and algorithms of life to slightly new situations. They want people who modify, not those radical random abstract folks with their penchant for unconventional creative behaviors. These creative problem solvers are barely acceptable in polite society. They have a knack for abandoning conventional solutions and finding really unique (and sometimes unsavory) ones. They are hardly team players and not readily acceptable by or as critical thinkers. And yet these creative problem solvers break the code and decipher the secrets of the universe. Of course, we have learners with both sorts of thinking preferences in our technology classes. Schultz (1985), for example, found that while 54% of 217 students in secondary industrial education programs scored as abstract sequential or concrete sequential learners (those people who prefer to learn applied algorithms), 20% scored as random abstract learners. In other words, in this sample almost one fifth of industrial education students preferred to learn to solve problems in a creative rather than lockstep fashion.

All people share creative and critical thinking attributes, but the individual usually prefers one mode of thinking over the other. Carl Jung (1976) compared this phenomena of the interaction between dominant and auxiliary psychological functions to handedness. Most people demonstrate a preference for using the right or left hand fairly early in life and that preferred hand becomes quite skillful; the opposite hand however remains relatively unskilled—just try writing your name with your dominant and auxiliary hand and it will be apparent which is skilled and which has remained undeveloped and childlike in its capabilities. And even though we right-handers learn to catch fly balls with a mitt on our left hand and master shooting layups from the left side of the basket, these skills are almost always less well developed than those of the right.

Over the last 20 years, we have moved away from traditional industrial education and strongly towards more rigorous forms of technology studies. We have sought to develop methods and programs that foster a higher order of thinking skills. Let us not do so at the expense of our ability to slip outside of conventional thinking and dream up really new paradigms. Think of Steve Jobs and Steve Wosniak at work in their garage, rethinking the ways that people and computers interact. Think of Einstein and his inability to master the algorithms of simple mathematics, yet able to rethink the universe. Remember Piaget's words, "The final form of learning is play." In our efforts to provide workers for industry and citizens for our society, the balance between training and education and between applying heuristics and solving problems with creativity is always a precarious one. In our secondary technology programs, we must take care that we do not lean more toward training than education.

References

Jung, C. (1976). *Psychological types*. Princeton, NJ: Princeton University Press.

Moates, D., & Shumaker, G. (1980). *An introduction to cognitive psychology*. Belmont, CA: Wadsworth.

Rogers, G. E. (1995). Technology education curricular content: A trade and industry education perspective. *Journal of Industrial Technology Education, 32*(3), 6–21.

Schultz, A. E. (1985). *The preference for intuition or sensation in 217 secondary industrial education students in Nebraska*. Unpublished doctoral dissertation, University of Nebraska-Lincoln.

Dr. Schultz is an Assistant Professor in the Department of Vocational and Adult Education at the University of Nebraska-Lincoln.

5. Technology: The Heartbeat of Education

by William D. Paige

What does the term *technology* mean? What does the term *engineering* mean? Are they one in the same? One collegiate dictionary defines technology as "...a scientific method of achieving a practical purpose; or the totality of the means employed to provide objects necessary for human sustenance and comfort" (Mish, 1988, p. 1211). Wright and Lauda (1993) defined technology as "...a body of knowledge and action, used by people, to apply resources in designing, producing, and using products, structures and systems to extend the human potential for controlling and modifying the natural and human-made (modified) environment" (p. 3). According to Savage (1991), technology is a body of knowledge and the application of resources using a systematic approach to produce outcomes in response to human needs and wants. Technology is "...the application of knowledge, tools and skills to solve problems and extend human capabilities" (Smith, 1994, p. 2). The common thread that runs through all of these definitions is that technology is about doing to extend human capability.

Engineering is defined as "the application of science and mathematics by which the properties of matter and the sources of energy in nature are made useful to people in structures, machines, products, systems, and processes" (Mish, 1988, p. 412). The Accreditation Board for Engineering Technology (ABET, 1997) defines engineering as "...the profession in which knowledge of the mathematical and natural sciences gained by study, experience and practice is applied with judgment to develop ways to utilize, economically, the materials and forces of nature for the benefit of mankind" (cover). Both engineering definitions emphasize utilizing a combination of mathematics and scientific theories with materials and nature to satisfy the needs of humankind.

From these definitions, it is easy to see that engineering and technology are not the same. The field of technology is much broader in scope than engineering. When comparing technology and engineering, Dugger (1994) found several areas of similarity as well as several distinct differences. Both engineering and technology are concerned with "how to" and "the solution of problems" (p. 8), and both are driven by "social acceptance and success at the marketplace" (p. 8). Both are based on the study of the principles of science, mathematics, processes, and systems. However, a fundamental difference does exist between technology and engineering. Technology places a greater emphasis on the application of these principles to solve problems and produce products while the focus of engineering is towards research, design, and developing new products and systems. The study of technology is directed from something concrete to the abstract while engineering is directed by theory and ends in specific recommendations or solutions. However, a certain level of interdependence does exist between engineering and technology as well. Engineering and technology are both dependent, to some extent, on one another. True progress is not possible without both.

Bensen and Bensen (1993) proposed integrating technology and engineering experiences into the school curriculum. They asserted that engineering and technology content organizers are built around (a) disciplines, (b) systems, (c) processes, and (d) impacts. Furthermore, they stated that "it is readily apparent that most contemporary and relevant technology education programs already include most of this content in their design" (p. 5).

It is true that several states have adopted or are developing programs designed to utilize engineering concepts. One such program is the Principles of Engineering from the New York State Education Department. This program takes a generic look at engineering through design activities and case studies. Currently, there are approximately 100 schools in New York using this program as a direct result of the National Science Foundation (NSF) providing funds for in-service experiences to train the teachers. Approximately 15 other states have also sent their teachers to receive this in-service instruction.

The state of Virginia has developed an Introduction to Engineering program with the assistance of practicing engineers. Several other states have also developed programs that integrate the study of technology with academic courses. In most cases, these programs are using problem-solving activities and table-top technology to gain understanding of the processes and concepts. Several of these programs, such as the ones in Colorado and Texas, have been showcased at national conventions. Any proposal of integrating engineering and technology simply utilizing organizers, course titles, and outcomes may not provide the desired results. Nevertheless, this certainly does open another avenue for discussion as to what is the role of technology education in the whole realm of education.

With all that having been said, it is easy to recognize that a problem still exists within the field that must be resolved. This seemingly age-old problem is one of identity, with many still asking questions such as the following: Are we pre-vocational? Are we a part of tech prep? Are we pre-engineering? Are we general education? These questions have been hotly debated for decades and most certainly since the American Industrial Arts Association became the International Technology Education Association. In an editorial, Sanders (1997) pointed out that the name change was designed to fuel a paradigm shift within the profession that would cause the American public to associate the term *technology* with our field of study. History has recorded that this did not happen. Sanders goes on to assert that we must educate the public about technology education and the importance of a technologically literate society. To accomplish this, we have to put aside the old debates and move our discussions to a different level, hopefully resulting in an application-based curriculum that prepares learners for a productive future in an ever-changing world.

We are all aware that the primary focus of the SCANS Report for America 2000 (U.S. Depart. of Labor, 1991) is the identification of skills young people need to possess upon completion of their formal education. These workplace competencies and foundational skills can be immediately put into practice by all students—those who choose to enter the workforce directly and those who plan to continue their education at a college or university. It is interesting to note the similarities between SCANS recommendations and the new goals currently being proposed in the literature for engineering programs. Industry leaders contend that technical abilities alone are not enough—communication and interpersonal skills, a willingness to adapt to change, and a strong sense of ethics are among the qualifications necessary to meet the basic needs of today's industry.

One area that is common to technology education and engineering education is the use of discovery or problem-solving activities in their coursework. These activities can have a lasting effect on students because nowhere else in formal education are students given the opportunity to participate in creative problem solving. Problem-solving activities, however, are not the end, simply the means by which one can reach a goal. They are a framework upon which one can build an understanding of technology. Problem solving is a method that can be used as a part of the overall educational experience to help produce technologically literate students. It is imperative that today's students not only develop the necessary foundation to appropriately select and use current technologies effectively, but also to make informed decisions about the technologies of the future.

Savage and Bosworth (1992) identified five strategies that will help produce technologically literate students:

> 1. Utilize technology to solve problems or meet opportunities to satisfy human needs and wants.
> 2. Recognize that problems and opportunities exist that relate to and often can be addressed by technology.
> 3. Identify, select, and use resources to create technology for human purposes.
> 4. Identify, select, and efficiently use appropriate technological knowledge, resources , and processes to satisfy human wants and needs.
> 5. Evaluate technological ventures according to their positive and negative, planned and unplanned, immediate and delayed consequences. (p. 1)

In conclusion, it is essential that all people have an understanding of technology and use it appropriately in today's world. Whether technology education merges with the field of engineering as suggested by some, or remains as a separate and distinct field of study, it simply must become an integral part of the educational program for every citizen. Technology is the essence of our way of life. The impact that technology has on all of our lives will do nothing but expand in the future. Therefore, to borrow and slightly modify a well known phrase, "Technology is the heartbeat of America," it must become the heartbeat of education.

References

Accreditation Board for Engineering Technology. (1997). *Accreditation yearbook for accreditation cycle ended September 1997*. Baltimore, MD: Author.

Bensen, M. J., & Bensen, T. (1993). Gaining support for the study of technology. *The Technology Teacher, 52*(6), 3–5.

Dugger, W. E., Jr. (1994). The relationship between technology, science, engineering, and mathematics. *The Technology Teacher, 53*(7), 5–8.

Mish, F. C. (Ed.). (1988). *Merriam-Webster's ninth new collegiate dictionary*. Springfield, MA: Merriam-Webster.

Savage, E. (1991). Determinants of advanced technological content in technology education curriculum. In M. Hacker, A. Gordon, & M. de Vries (Eds.), *Integrating advanced technology into technology education* (Series F, Vol. 78). New York: Springer-Verlag.

Savage, E., & Bosworth, F. (1992). *Secondary grades technology education: Technology literacy and problem solving in action*. Reston, VA: International Technology Education Association.

Smith, W. H. (1994). Application of technology systems. In *Technology education graduation outcomes: Questions and answers. The Donald Maley Monograph Series (Monograph 1).* Reston, VA: Industrial Technology Education Association.

U.S. Department of Labor. (1991). *What work requires of schools: A SCANS Report for America 2000*. Washington, DC: U.S. Department of Labor, The Secretary's Commission on Achieving Necessary Skills.

Wright, R. T., & Lauda, D. (1993). Technology education—A position statement. *The Technology Teacher, 52*(4), 3–5.

Dr. Paige is a Professor in the Department of Technology and Human Resources Development at Clemson University, South Carolina. He is Trustee of the Gamma Tau Chapter of Epsilon Pi Tau.

6. A Learning Styles Instrument to Enhance Learning in Technology

by Larry D. Kuskie and Marlene M. Kuskie

The technology curriculum has been defined and redefined, and it continues to evolve to keep pace with technological discoveries. As a consequence, most states have written and implemented technology programs within schools, which have acquired impressive equipment. But, the technology teacher needs to address how the technology equipment and curriculum can be utilized to best enhance student learning.

We believe that matching students to their learning styles can be the vehicle to the successful implementation of curriculum and the appropriate use of technology equipment to meet student learning outcomes. The student learning inventory discussed in this article was developed to demonstrate how the creation of an easy-to-understand inventory and minor adjustments in the teaching-learning process can make a significant difference in the learning process.

Learning styles or modalities are the manner in which students learn or change as the result of an experience (Roundtree-Wyley, Frusher, & Ficklin, 1988). Research shows that attention to teaching methodologies that address student learning styles increases learning and develops the potential ability of students to learn (Carbo, Dunn, & Dunn, 1986; Foriska, 1992; Henak, 1992). According to Jenkins (1988), when teachers begin to adjust instruction to diagnosed learning style differences, academic achievement increases and attitude toward learning is more positive. As a result, many learning style inventories (James & Galbraith, 1985; Kolb, 1985; Myers & McCaulley, 1985) have been developed for a wide variety of populations.

For the purpose of this project, information processing and instructional categories of learning styles were considered. Interestingly, Johnson and Thomas (1994) discovered that novice learners without a knowledge base concerning a particular problem relied upon the senses to guide the learning process. Johnson and Thomas also found that the ability to select an appropriate strategy is an essential element of the problem-solving process. Assisting students to use the appropriate learning modality of visual, auditory, or psychomotor senses has the potential of enhancing problem solving and student learning outcomes.

After a review of the literature (Flaherty, 1992; Geisert & Dunn, 1990; James & Blank, 1991; Loper, 1989; Orsak, 1990; Roundtree-Wyley et al., 1988) and in an attempt to develop a learning style inventory that would be compatible in the technology classroom and that would be readily understood by a variety of students, the authors chose and developed the categories of visual, auditory, and psychomotor for their instrument, the Learning Channels Inventory(LCI). Waetjen (1993) stated that all three modes are used in the technological process of learning. All modes are equally important, but each style has advantages and disadvantages for the student learner.

The uses of the LCI for the technology classroom is multifaceted. The primary goals are (a) to enhance the learning of the technology curriculum, (b) to consider how students might most effectively learn and use the technology equipment, and (c) to expand the instructional methods of the technology teacher. By considering learning styles, students become more involved in the learning process, cooperative learning groups can be structured to value the diversity of learning styles, and students can be more successful in the learning process.

LEARNING CHANNELS INVENTORY

We developed the LCI for technology teachers in the middle and secondary school classroom. We administered the inventory twice to students over a period of a semester for a test-retest reliability of 80. Although students have the ability to learn in all three styles, the inventory will indicate a predominant style or modality.

A visual learning style is used by those students who would rather see the ideas on the printed page, on an overhead, or be shown how to do an activity. These students profit best by reading materials (textbooks or other such materials rather than lectures), by taking notes and writing reports, and by demonstration and observation. These students will seek information by reading rather than by asking another person. These students will take notes to better remember the concepts but often need to be shown how to do an activity.

The auditory learning style, described

as learning that occurs through hearing, is often the least developed channel but is the most often used method of instruction (lecture format) at the secondary level (O'Brien, 1989). For students who prefer the auditory channel, talking and listening become very important. Reading aloud and discussing their thoughts are vital to the learning process. Such students learn most optimally in small groups and by having other students listen to what they have to say and how ideas sound. Lectures by teachers can become boring if the students are not able to talk and respond to the ideas.

The psychomotor or haptic/kinesthetic learning style refers to students who learn best through hands-on activities. Learning must be action oriented. The technology laboratory becomes an ideal environment for these students. Often the technology equipment limits the number of students in the classroom, which also enhances the opportunity for psychomotor students to be actively involved in the learning process. Psychomotor-oriented students can be frustrating to the technology teacher because they are often punching keys or buttons without taking the time to read the manual or asking for assistance.

USE AND IMPLEMENTATION OF THE LCI

The LCI (see Table 1) should be administered at the beginning of the learning term so that results may be reviewed by the students and the teacher. Students are encouraged to respond to each item as it relates to their particular preference. There are no right or wrong answers. If needed, each item can be clarified by the teacher using additional examples. The final profile or clusters of responses indicate what is true for the students as they have perceived the statements. The profile is interpreted, with the lowest number of responses being their predominant learning style and the highest number of responses being their least preferred learning style. The Interpretation Guide for the LCI (see Table 2) might then be distributed to students for future reference.

A profile that has a similar number of responses in each category indicates (a) that the student has developed all three learning modalities and probably adapts to the learning situation and the modality of the material being taught or (b) that the student has not discovered a learning channel that is most efficient or effective and often does not achieve well since the student does not know how to adapt or choose a learning style that best fits the situation. The LCI can become a teaching/learning device to help the student begin to discover and develop a more efficient way to learn or problem solve based on that particular situation.

A discussion of the Interpretation Guide with either the individual student or within the classroom becomes the opportunity for the technology teacher to talk about the problem-solving process and how learning can occur most effectively. The learning style will often determine how the student may best learn on a particular piece of equipment. The students are not only encouraged to consider predominant learning style, but also the development of other modalities.

The technology teacher needs to record the profiles of each student so that learning groups and teaching methodologies are adapted for the particular class. Different teaching methods can be adapted depending on the nature of the learning module. Table 3 is an example of adapting the learning style to a particular learning module.

Another use of the LCI is to place students in cooperative learning groups consisting of students with all three predominant learning styles. The learning objective may be to have the students develop a learning methodology/aid according to each learning style for a particular piece of technology equipment. For example, if the cooperative learning group was responsible for developing a visual method to teach someone how to use a particular piece of equipment, the students with a predominant visual learning style in the group would be consultants to the group in the development of the learning device (i.e., drawing a step-by-step diagram or developing a videotape demonstration). The problem-solving process of how the group members functioned in the role as consultant and creator also needs to be evaluated.

In order to better link the information gained from the LCI, the students might be assigned to evaluate other classes and determine how different learning styles may need to be utilized and adapted depending on the situation.

The students might also learn by creating new items for the inventory that are more relevant to identifying the categories of visual, auditory, or psychomotor considering the specific experiences in the classroom. In particular, the students need to be encouraged to supplement other ways and means to learn in the various styles using the Interpretation Guide. The Interpretation Guide is meant to stimulate discussion and understanding and to guide the learning process.

HINTS AND CAUTIONS

The technology teacher should plan the learning process to involve the learning modalities of seeing, hearing, and doing. At the same time, if the teacher teaches and evaluates only in one learning modality (which is often the teacher's predominant learning style), the teacher is accurately assessing only those students who prefer that mode (Loper, 1989). Teaching in only one predominant modality will meet only a portion of the students' needs and creates unnecessary stress and confusion which reduces student motivation and restricts student performance (Roundtree-Wyley et al., 1988). Thus, students and teachers need to explore a variety of methods of teaching and learning.

Knowledge of the predominant learning style is important for the technology teacher in planning activities for both the student and the group (James & Blank, 1991). Individually, activities and modules can be matched to a student's predominant learning style and the student can be encouraged to develop another learning style depending on the particular module. But even more important, the technology teacher needs to incorporate the knowledge of predominant learning styles into how cooperative learning groups, other small groups, and dyads are formed. For example, by matching different learning styles on a module, the students will use each other's talents to discover how to use the equipment for further problem solving. In a problem-solving sequence, the learning perspectives—which introduces more information into the process—will cause solutions to be reached

Table 1

Learning Channels Inventory

Directions: Read each item and prioritize the activities according to your first, second, and third preference. Be sure you enter a different number in each blank to indicate the order in which you ranked them 1 = first choice, 2 = second choice, and 3 = third choice.

1. You are a member of the new Technology Student Association (TECA). As a member you would rather
   _____ a. serve as secretary and keep written records.
   _____ b. plan future meetings/projects by talking to the other students.
   _____ c. set up paraphernalia for meetings and gather any other materials for meetings and projects.
2. When putting together a robotics model, you would
   _____ a. follow the directions found in the instruction book.
   _____ b. prefer that another student read the directions while you put the model together.
   _____ c. begin putting the robot together relying on your past knowledge and what seems to fit or work.
3. When studying for a test, do you
   _____ a. write summaries to help you remember important items?
   _____ b. read over your notes aloud to assist you in remembering or have someone quiz you?
   _____ c. draw pictures or find a pneumonic device that would help you remember?
4. When memorizing the numbers to a G code on a CNC machine, you would
   _____ a. form a picture in your head of the code.
   _____ b. repeat them over and over to yourself.
   _____ c. write the number down on a piece of paper.
5. A new student is introduced to your class. How would you remember his or her name?
   _____ a. relate their name to some particular characteristic about them.
   _____ b. relate their name to something that rhymes.
   _____ c. write their name down over and over on a piece of paper.
6. Your technology teacher has asked you to respond in class. Which method is more comfortable to you?
   _____ a. refer to what you remembered in the book.
   _____ b. talking about what you heard the teacher/students say.
   _____ c. use a piece of equipment to demonstrate your answer.
7. The technology teacher is presenting information in class concerning different uses of satellites. Would you rather
   _____ a. have the instructor give you written directions to follow?
   _____ b. listen to the instructions that are given by the instructor only?
   _____ c. explore how the satellite works and experiment to make it operate?
8. Your instructor has just received a complete stereo system for the technology laboratory. The instructor has asked you to put it together. You would
   _____ a. read the written directions to solve a problem.
   _____ b. make a phone call to the company to get a problem solved.
   _____ c. keep moving wires around until the problem in the stereo system is solved.
9. When listening to a new hit song that has just swept the country, you would
   _____ a. look at the lyrics on the package.
   _____ b. sing along with the lyrics.
   _____ c. write the lyrics down on a piece of paper and tap your foot to the beat.
10. The technology teacher has just received word that the students in the class have been selected as the most outstanding students in the school. The teacher is very excited and happy. How could you tell?
    _____ a. observe the teacher's body language.
    _____ b. listen for the teacher's voice inflection.
    _____ c. notice the teacher shaking hands with the students.
11. You have just finished your module work on lasers. Your teacher just told you that the next 30 minutes are free time to work on individual interests in the lab. You would
    _____ a. start reading the next assigned module or figuring out something else you've wondered about.
    _____ b. use the time to talk to other students about their projects.
    _____ c. use the time to construct or build something new.
12. The technology teacher has just presented some very important information concerning problem solving. You would
    _____ a. concentrate deeply on the reading material handed out.
    _____ b. concentrate deeply on what the instructor was saying.
    _____ c. concentrate deeply on the task required to complete the assignment.
13. A friend of yours has just won a gold medal in the state track meet. You would
    _____ a. congratulate the friend by writing a note.
    _____ b. call the friend on the telephone.
    _____ c. give the friend a hand shake the next time you see him or her.
14. Which one of the following games would you rather play?
    _____ a. Scrabble
    _____ b. Wheel of Fortune on TV
    _____ c. Slap Jack
15. You are en route to a friend's house when you become lost. You would
    _____ a. get a map out to find your way to the location.
    _____ b. stop and ask for directions from someone on the street.
    _____ c. keep driving and guessing until you find your way.

Scoring Directions:
Have the students add all the numbers in Category A. Then have students add the numbers in Categories B and C. The category with the lowest number would indicate their learning style. Category A indicates that the student is a visual learner, B indicates an auditory learner, and C indicates psychomotor tendencies. If two categories are tied or very close, this indicates that the student has not developed one area over another or uses the style that is needed by the particular learning situation.

Profile Total	Category A	Category B	Category C
	_________	_________	_________

Table 2

Interpretation Guide for the Learning Channels Inventory

Visual Preferences	Auditory Preferences	Psychomotor Preferences
• Reading a textbook	• Prefers lecture to reading a book	• Learns best by moving and experience
• Rules and lists	• Likes discussion in small groups	• Likes hands-on activities
• Likes charts, graphs, and pictures	• Likes videos	• Likes to do rather than read
• Takes notes	• Reads out loud	• Reads for meaning not detail
• Likes overheads and slides to supplement lecture	• Often first to answer questions	• Usually does not read for pleasure
• Wants quiet to learn	• Thinks out loud	• Often has illegible handwriting
• Needs handouts and worksheets	• Listens to tapes	• Tendency to stand close to people
• Prefers written tests and reports for assessment/evaluation	• Likes to hear explanations	• Poor test taker
• Likes demonstrations	• Prefers oral assessment	• Talent for working with hands
• Visualizes on computer		• Often likes vocational classes
		• Needs more time to finish projects
		• Likes to use computers instead of reading

Table 3

Adapting learning style to a particular learning module.

Learning Module	Robotics
Visual	Use of the manual, videotape, demonstration
Auditory	Prerecorded message of instructions, collaborative learning group, lecture
Psychomotor	Experimentation with basic lab instruction, simultaneous use of robot with videotape

sooner. Students will begin to respect each other's styles and value their contribution to the process. By matching students with similar learning styles, the students can help each other prepare for tests and learn from each other since students with the same predominant learning style will speak the same language. Technology teachers need more than observation to determine the dominant learning style of the student. The LCI provides the tool to assist the teacher and student.

The LCI is a springboard to encourage the technology teacher to integrate learning process concepts into the technology classroom. Technology is not only learning a piece of equipment, but it is a study of the learning process. The more students can become aware of the learning process, the better the student can transfer learning concepts and continue learning independently as technology equipment changes. As the technology teacher becomes creative in different teaching approaches, the more students will expand their potential to learn.

References

Carbo, M., Dunn, R., & Dunn, K. (1986). *Teaching students to read through their individual learning styles*. Reston, VA.

Flaherty, G. (1992). The learning curve: Why textbook teaching doesn't work for all kids. *Vocational Education Journal, 67,* 32–34.

Foriska, T. (1992). Breaking from tradition: Using learning styles to teach students how to learn. *Schools in the Middle, 2,* 14–16.

Geisert, G., & Dunn, R. (1990). Learning styles and computers. (ERIC Document Reproduction Service No. ED 332 268)

Henak, R. M. (1992). Addressing learning styles. *The Technology Teacher, 52,* 23–28.

James, W. B., & Blank, W. (1991). A comparison of perceptual learning styles of adult high school graduates and non graduates. *Adult Basic Education, 1,* 98–106.

James, W. B., & Galbraith, M. W. (1985). Perceptual learning styles: Implications and techniques for the practitioner. *Lifelong Learning, 8*, 20–23.

Jenkins, J. M. (1988). A learning style approach to effective instruction. In J. W. Keefe (Ed.), *Profiling and utilizing learning style* (pp. 41–44). Reston, VA: National Association of Secondary Principals.

Johnson, S., & Thomas, R. (1994). Implications of cognitive science for instructional design in technology education. *The Journal of Technology Studies, 20*(1), 33–45.

Kolb, D. (1985). *The learning style inventory and interpretation booklet.* Boston: McBer.

Loper, S. (1989). Learning styles and student diversity. *Educational Leadership, 46,* 6.

Myers, I. B., & McCaulley, M. H. (1985). *Manual: A guide to the development and use of the Myers-Briggs Type Indicator* (2nd ed.). Palo Alto, CA: Consulting Psychologists Press.

O'Brien, L. (1989). Learning styles: Make the student aware. *NASSP Bulletin, 73,* 85–89.

Orsak, L. (1990). Learning styles versus the Rip Van Winkle Syndrome. *Educational Leadership, 48*, 19–21.

Roundtree-Wyley, J., Frusher, S., & Ficklin, T. (1988). A comparison of learning styles in traditional and non-traditional students. (ERIC Document Reproduction Service No. ED 310 671)

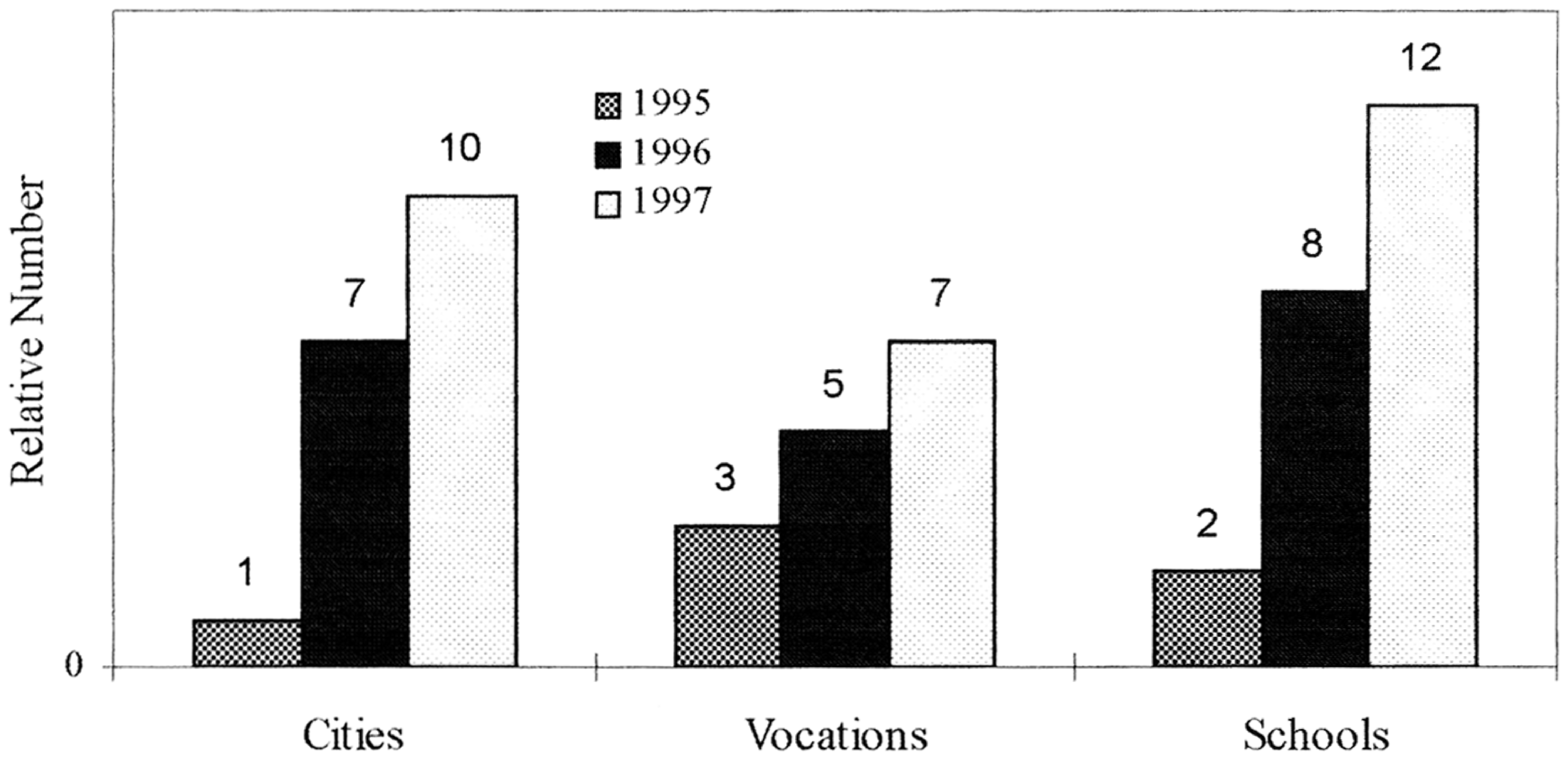
Waitjen, W. (1993). Entropy and technological learning: A cognitive approach. *The Journal of Technology Studies, 19*, 2–29.

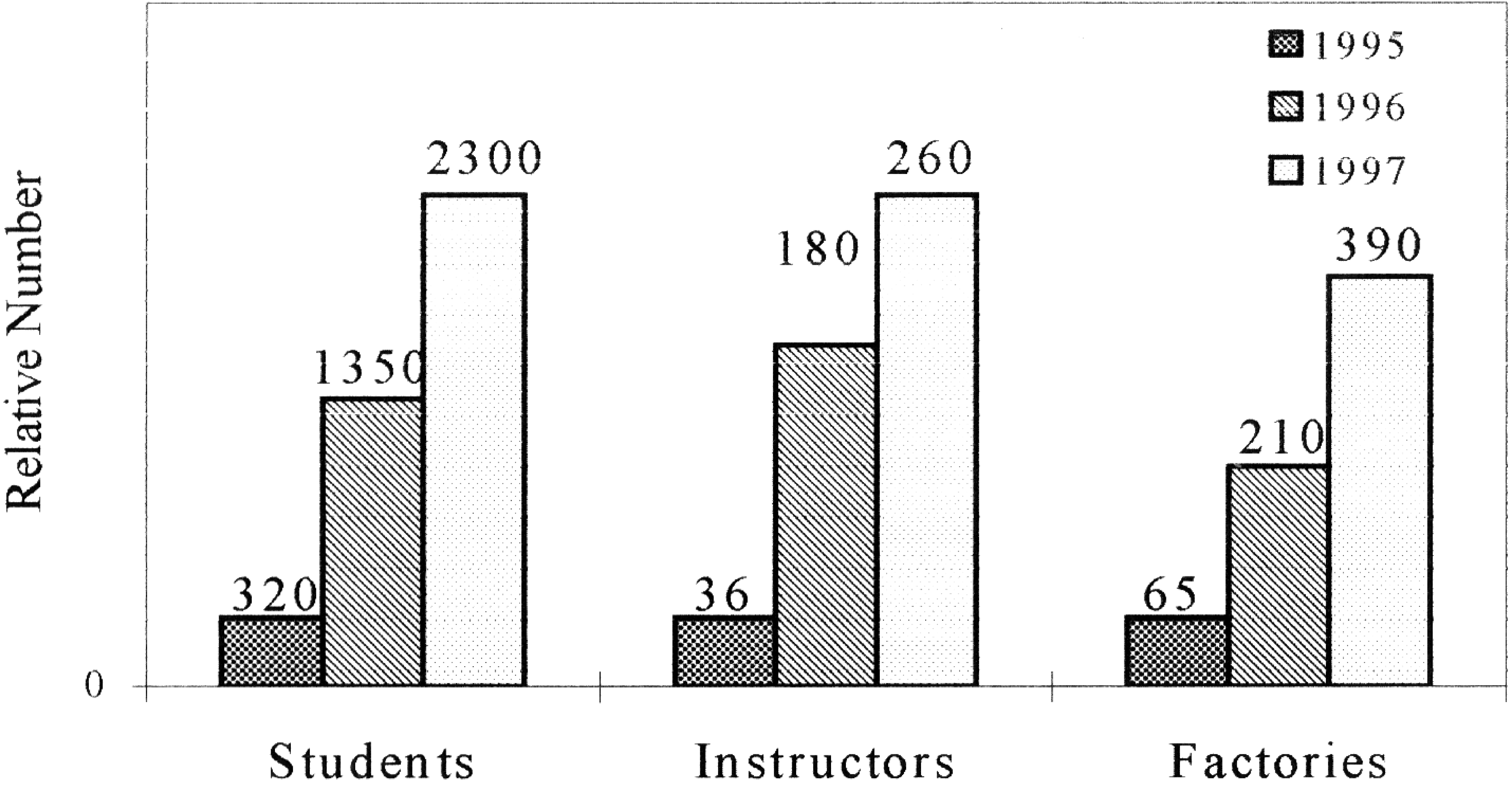
Dr. L. Kuskie is the Chairperson of the Department of Industrial Technology at the University of Nebraska at Kearney. Dr. M. Kuskie is an Associate Professor in the Department of Counseling and School Psychology at the University of Nebraska at Kearney.

Epsilon Pi Tau's Editorial Board is currently soliciting articles on these themes:

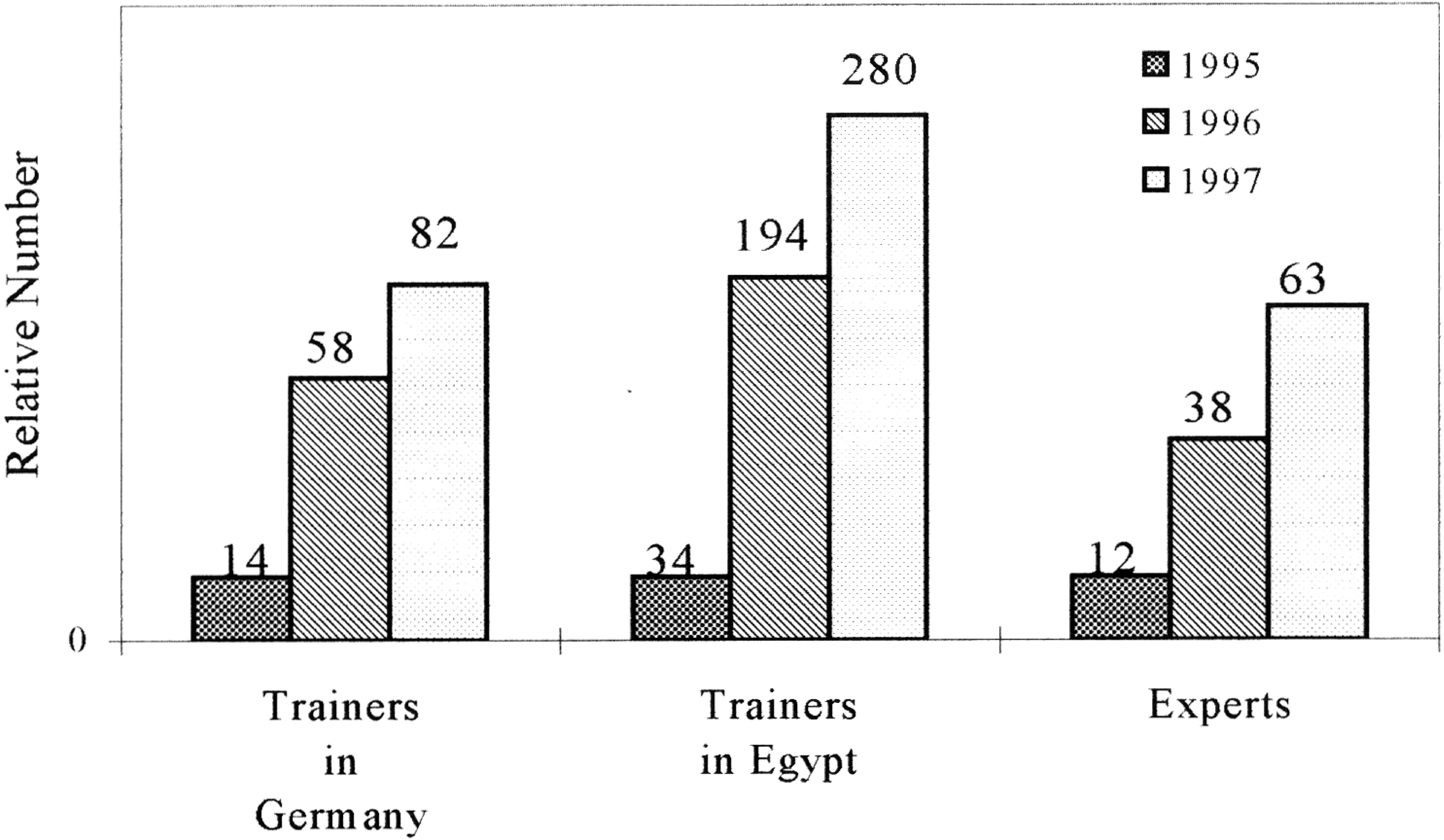
- Women and Technology
- Imagining Cyberspace
- Managing the New Techies: Smart, Feisty, and Entrepreneurial
- Techno-Diversity: People of Color and Technology
- Saving the Best for First: How community Colleges Make Technology Education Happen
- Educating the Universe: A Status Report on International Technology Training

Feel free to contact Ce Ce Iandoli at her e-mail address with your letters of inquiries or abstracts at: cecei@aol.com or submit a full-length manuscript which follow form and style described in the *Publication Manual of the American Psychological Association* (fourth edition 1994, particularly as pertains to citations, references, tables, figures, and headings.


Relative Number
1995
1996
1997
0
1
7
10
3
5
7
2
8
12
Cities
Vocations
Schools



Relative Number
0
320
1350
2300
36
180
260
65
210
390
1995
1996
1997
Students
Instructors
Factories



1995
1996
1997
Relative Number
82
58
14
280
194
34
63
38
12
0
Trainers in Germany
Trainers in Egypt
Experts