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From the Editor

Have you noticed that technology education has become a hot topic the world over? If not, have your senses checked... at least two of them must be malfunctioning. Everyone seems to agree we ought to be teaching young people about technology. The questions being asked, though, are&gml. Who should shoulder this responsibility? And how should they go about it?

Technology (formerly industrial arts) teachers approach the task with a century of :q.hands-on:eq. experience under their collective belt. They boast a rich tradition of motivating young people with hands-on activities. Working from their :q.project method:eq. heritage, industrial arts-turned-technology teachers are working on curriculum :q.upgrades:eq. that are :q.technology:eq. rather than :q.industry:eq. based. In the process, :hp1.project building:ehp1. activities are being replaced by :hp1.problem solving:ehp1. activities, which are believed to be better suited to teaching the technological systems inherent in the new curriculum.

While I still have a lot to learn about the Science, Technology, and Society movement, it is obvious they approach technology education from a substantially different perspective. Traditionally, science is the study of principles and theorems. Yet, as Roy suggests in his guest article, this approach to :hp1.abstract:ehp1. science may be appropriate for only a relatively small subset of the secondary school population. Infusing :hp1.applied science:ehp1. and technology in the science curriculum is seen as a way to :q.reach:eq. a larger audience.

Technology education in Great Britain has evolved out of the craft and design tradition. Accordingly, the British seem to stress the developmental design process in their study of technology to a greater extent than do either the STS or the industrial arts/technology educators in America.

My sense is that each camp has both much to offer and much to learn from the others. Curriculum development in industrial arts/technology education, for example, has borrowed problem solving ideas from the British. At the same time, an increasing number of scientific principles are being stressed in these curricula. STS, on the other hand, seems to be advocating more hands-on activities as a means of making science more applied and less abstract.

You'll see some of that interchange going on in this issue of the JTE. Roy's guest article provides both a rationale of sorts and a general structure for STS education. Denton's editorial gives those of us on this side of the Atlantic a peek at his thoughts on the importance of teamwork in the technology education classroom. Braukmann and Pedras offer a straightforward prescription for the problem solving method. Korwin and Jones, Litowitz, and Scarborough share their research findings, while Wilkinson gives us a piece of his (Canadian) mind. Or, there are reviews by McCade and Snyder, if you would rather just settle down with a good book...

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Preparing Students for Living in a Technological Society: A Problem Solving Approach to Teaching

James R. Braukmann
Melvin J. Pedras(1)

The ever changing perception of the roll of technology in our society provides educators with a myriad of challenges and problems for the curriculum. Technology is alternately seen as a major source of society's problems, or as the salvation of society. This confused role, compounded with the current trend toward life-long learning, and the need for future citizens who can function effectively in a modern technological society, provides educators with innumerable opportunities for integrating realistic problem solving techniques into the teaching environment. The purpose of this article is to provide practical suggestions on how a technological problem solving environment can be created and used by educators in any area of study to help prepare students for living in our modern society.

Addressing the issue of technological change and the need for educators to teach problem solving, the National Science Board Commission on Pre-College Education in Mathematics, Science and Technology (1983) noted the effects of technological changes in its report:

> We must return to basics, but the basics of the 21st century are not only reading, writing, and arithmetic. They include communication and higher problem solving skills, and scientific and

technological literacy -- the thinking tools that allow us to understand the technological world around us... Development of students' capacities for problem solving and critical thinking in all areas of learning is presented as a fundamental goal.

The commission's report indicates that society has undergone significant changes. Many of these changes and problems facing society have occurred because of advancing technology. Robert Ornstein (1985) of the Institute for the Study of Human Knowledge wrote:

Solutions to the significant problems facing modern society demand a widespread, qualitative improvement in thinking and understanding. We are slowly and painfully becoming aware that such diverse contemporary challenges as energy, population, the environment, employment, health, psychological well-being of individuals and meaningful education of our youth are not being met by the mere accumulation of more data or expenditure of more time, energy, or money... We need a breakthrough in the quality of thinking employed both by decision-makers at all levels of society, and by each of us in our daily affairs.

Hatch (1988, p. 88) notes that society is in desperate need of individuals capable of finding viable solutions to a variety of challenges. These needs have prompted many leaders to suggest that education now implement methods of teaching that can enhance the problem solving ability of students. According to Costa (1985, p. 4), however, "most teachers do not regularly employ methods that encourage and develop thinking in their students."

We as educators, and especially those concerned with technology and general education, have an opportunity to fill a void in the liberal education of students. We understand the role humanities and the social sciences play in the preparation of students for living. Integration of the humanities and social sciences with math, science, and technology, enables students to think more creatively and identify technological solutions to real-world problems.

If students can be placed in a problem solving role as they study ethics, sociology or history, they can learn to recognize very real problems under the guidance of an experienced professional. An example would be to consider the implications of replacing workers with automated equipment. Should the criteria for this decision be limited to the availability of such technology, and the potential for increased production? What will be the effect on displaced workers? What responsibility does management have for the personal development of workers in a technology related field? What lessons can be learned from the study of history, ethics, or philosophy? Problem solving techniques can help students in the systematic delimitation of such problems, the listing of possible solutions, the analysis of effects of potential solutions and in with the logical selection of a potential solution.

PROBLEM SOLVING AS A TEACHING METHOD

Students need the same acquired skills in business and industry as are necessary for success in any professional field -- communication and interpersonal skills, linked to problem solving skills.

Today in industry, a designer or management professional will be working on a project group or product team with a directive to find the best solution to a critical question. No longer can any one person be expected to master a body of knowledge, with available information doubling every six years. As an example, an industrial designer in the 1950's might have needed to be expert in mechanical design, steel fabrication and hydraulics. Today, the list could easily include digital controls, computer interfaces, data communication protocol, light and pressure sensors, radio frequency interference, and more. Their background should also include ethics, philosophy, social sciences, and the ability to interrelate the basic tenets of these disciplines with technology. Not even the most gifted engineer can be expected to know enough about all of these fields to develop an adequate design by today's standards. However, a group who's collective expertise covers this list could succeed, assuming that they could work together and draw on each member's strengths.

The ability to function effectively in a project group involves skills that are often addressed by technology education. However, the skills are not unique to technology, but broad based and applicable to many endeavors in an increasingly complex society . We can cluster these skills into two general categories -- group dynamics and problem solving strategies.

Group dynamics includes leadership, communication, presentation, and persuasion skills. These skills are vital in business or academia, in industry or politics, from committee work to designing. We should compel students to use them. For example, if a group of students will be evaluated on a final cooperative product, and no one member can manage all the work, persuasion, communication, and cooperation will develop. The group must find ways to organize and communicate internally and externally to accomplish a common goal.

The second category, problem solving strategies, includes the design process, information management, and learning skills.

Creativity is not difficult to cultivate. The following problem solving model (Figure 1) is borrowed from science and technology. The process it describes works for a single person or a group, and in disciplines as divergent as the humanities and social sciences, business and education.

1. Define the problem carefully and completely. Everyone involved in a challenging project needs to understand the problem in order to avoid counter-productive or divergent goals. Any time so spent will save time in later stages.

   Many problems in our society are solved simply by being successfully identified and isolated. Consider, for example, the problem of excess waste material. The problem might be more clearly defined as one of how to develop an efficient disposal system, or to find constructive use for the waste material, or to find a way to decrease the amount of waste material produced. Each of these three definitions of the problem will generate different criteria.

2. Establish criteria for a solution. All those involved must set and agree to realistic goals, limitations, and expected or possible consequences. Be careful to allow for future adaptations that may become necessary, but are not immediately apparent. Finally, agree to a schedule for the completion of the process steps. All this will set up the evaluation phase to come later.

   Questions to ask at this point might include: What must be accomplished? With what accuracy? How will the solution interact with other factors? Do limitations, such as cost or size, exist? Must the solution be transportable? Once initiated, must the solution be selfsustaining? Must it be adaptable? Will there be a negative environmental impact? If the solution involves a machine, can the machine be easily produced? Can it be easily repaired? Are there any potential safety problems? How important is the appearance? Will it be used for promotional activities?

3. Research possible solutions. Information management is necessary to avoid reinventing the wheel. Has this problem been solved before? Are there lessons to be learned from other's mistakes? Where can information on similar topics be found? A specific example from technology might be to find and compare the strength-to-weight ratios of steel, aluminum, and hardwood in order to choose the best material for a certain application. The key is to promote the use of libraries and research techniques.

4. Brainstorm all sensible and seemingly non-sensible potential solutions. Make this an open activity with as much latitude and as few rules as possible. At this point, the ideas do not have to closely match the criteria. Quantity of ideas is better than quality. Specify a group member to record as quickly as possible the widest variety of ideas without judging them. Any evaluation of these ideas is left to the next step.

5. Narrow the acceptable or promising options and develop them. Sketchy, brainstormed ideas need to be expanded before they can be completely evaluated. This process can be done by individuals or subgroups of two or three students who see potential in one of the ideas. Presentation and persuasion skills are fostered by having student subgroups favoring specific solutions compete, and

be evaluated by the whole group, or by the teacher acting as manager. Communication here becomes more than an exercise in that it is an opportunity for student to persuade others of the value of their point of view, or for the student to avoid having to adapt to the point of view of another. This opportunity tends to be taken rather seriously.

Students should be taught that a better presented idea has as good a chance of prevailing in this arena as a better idea. A project development team that is armed with production drawings, decisions supported by research, and an organized presentation will be most persuasive. Another team with a promising idea that has not been completely worked out, or with a confusing presentation will be less persuasive. Finally, the teacher/class should select one or more of the most promising solutions, using the criteria developed in step 2 above.

6. Create a working model or models. In a typical problem solving exercise, project leaders are assigned, within teams, with responsibility to organize the effort. Team decisions are made outlining individual responsibilities, and the manner in which the individual efforts will fit together. Procedures must be in place to handle new problems that might appear. All communication from this point needs to be documented: memos from the project leaders, and reports from the project workers.

   Within the teams, students are working and communicating for a purpose. Their individual effort is needed by others to solve the problem and achieve the common goal.

7. Evaluate the end result. At this point the end result must be compared to the

criteria established in step 2, above. If it does not meet the criteria, a redesigning or rethinking cycle may be initiated. Perhaps other solutions from step 5 might be re-evaluated. If the solution does meet the criteria, can it be easily improved? Does the particular way in which this problem is solved create new problems? Perhaps the original criteria need to be re-evaluated. Necessary changes are made and the final end result is formally presented to the class. This process is capable of generating thoughtful and refined solutions, as well as opportunities for enhancing leadership, communication, presentation, and persuasion skills.

THE ISSUE OF TECHNOLOGY LITERACY

A disturbing trend of 70s and into the 80s, is the delivery of a general education without relating curriculum to the realistic social framework of an increasingly technological world. Students who do not understand the implications of abruptly replacing an industrial worker with a robot, confusing power with license in genetic engineering, or limiting access to computer information as a cause for social stratification, do not understand the ultimate nature of a liberal education.

When establishing criteria for the development of a new product, is it enough to consider only the market potential and profits to be made? What are the long term implications for social institutions? What will be the impact on future supplies of natural resources? In a decision to market a telephone that displays the caller's number, what are the implications for such issues as a right to privacy and freedom of speech? In supplying cost effective aerosol containers, should the destruction of the ozone layer be considered?

Every technology teacher has overheard students objecting to the history, economics or government classes that they "have to take." Such integral parts of a balanced curriculum must be made relevant to these students. Through the use of a problem solving strategy, the study of technology can be related to social, economic, and environmental issues. Additionally, technological topics and similar problem solving strategies in humanities and social science classes can provide students with an understanding of the problems of our technological society that would otherwise be elusive. We cannot afford to have a curriculum which is too often desultory, inconsistent and lacking in rigor as reported in a recent issue of the Chronicle of Higher Education. (DeLoughry, 1989)

Cote observes that as the specific problems assigned in a class will support the course content, the manner in which the solutions are achieved can support broader goals related to interpersonal working relationships, communication, and problem solving skills. The role, then of the educator should be to provide the student with appropriate experiences for defining and solving problems. (Cote, 1984)

SUMMARY

A continuing challenge to educators is to prepare broad-ranging thinkers with the skills to confront the problems of the future. In this endeavor, we cannot afford to continue to isolate technology from humanity, or we run the danger of using technology for it's own sake, unrestrained by heritage and careful consideration, in a society that equates computer prowess to license.

As a curriculum in technology can be improved by relating the core material to social and humanistic value systems, so might a curriculum in the humanities or social sciences be improved by a focus on the problems and potentials of technology in an increasingly complex society.

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The Role of Teamwork in Technology Education: Observations From an Action Research Program

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Technological education has a central role to play in the education of children and development of modern society. We can instantly recognize the basic vocational dimension, but possibly of more importance is the role of technology in general education; that is the development of technological awareness in all children, the realization that "it" is within our control and not beyond it. Persig's (1974) message in ZEN AND THE ART OF MOTORCYCLE MAINTENANCE is as fresh as ever and certainly should be essential reading for every teacher in the field of Technology.

There have been many definitions of technological education, however they tend to focus on content, such as electronics, mechanics, etc. The National Curriculum developments in England (HMSO, 1989) have refocused the definition of Technology into a process led model where content is secondary to the basic technological design process. Despite this welcome re-appraisal of technological education, there is an obvious omission in the assessable attainment targets -- i.e. the ability of children to work as efficient members of a team. The above statement may appear strange, but if we look to industry for a model of technology, we see teams of people involved in the design and production of artifacts, systems and environments. Note that the central foci are the task and the team - not a specific body of knowledge. I do not suggest that a knowledge base is unimportant, only that it should be recognized that teamwork and the management of a task are equally important.

Teamwork falls within the overall concept of groupwork. I would differentiate by suggesting that groupwork occurs when a number of children share a learning experience such as a textbook. They are engaged in the same task but work independently, although discussion may take place. All members of the group go through the same learning process and produce similar results. In a team, children would manage a task in which individuals would not necessarily have the same learning experience. Discussion would be essential rather than simply possible. The task would be broken into sub-tasks and delegated. Everybody contributes to a bigger whole.

Teamwork clearly cannot be used in teaching strategies where it is important that a certain body of knowledge is understood by all children. Teamwork exercises can, however, greatly enhance learning situations where the emphases are on exploration, open-ended learning and the application of knowledge to new contexts. Here team work approaches can increase levels of interest and application, increase perceived relevance, and develop the skills children will need when they enter the world of work. Such teamwork exercises, whatever their context, do need careful and long term planning for progression.

Industry has frequently called out for teamwork skills to be developed in children. Peacock (1989), speaking at the Loughborough DATER 89 conference as research director of Phillips, was very clear as to his requirement for teamwork skills amongst the technologists he employs. There is evidence that consensus development in teams is more likely to lead to better results than if individuals work alone (Ginifer, 1978). Why then, is it relegated so far in educational thinking? The answers to this question lie in the field of assessment and the self perpetuating system of teachers who tend to have little or no industrial experience.

Educational assessment in England revolves around the General Certificate of Secondary Education (GCSE), administered on or after age 16. This is basically a Nationally organized and externally moderated system of examinations. These examinations cannot assess an individual's ability to work as a member of a team, they are really only suitable for assessing knowledge and a limited range of skills. Lewin (1989) in a lighthearted, but serious critique of examinations as assessment instruments, pointed out that:

1. all problems last 30 minutes
2. all problems have a definite answer
3. you must work on your own
4. all problems have just the right information, no more, no less
5. no copying

The English educational system has tended to develop around the teaching of the easily assessable. Many skills and attitudes which children will need in life are not easily assessed and are therefore left out of assessment schemes. It was very noticeable that the Working Party developing the Science guidelines for the National Curriculum included "teamwork skills" within their report as Attainment Target 18. This commendable effort was reversed in the final statutory document. Reasons have not been given but it is reasonable to assume that it would be assessment difficulties.

Whilst the GSCE system cannot assess teamwork performance with the required reliability and validity, it is my thesis that it is simply too important to be ignored. Profiling and records of achievement offer insights into such abilities -- we should use them. They do not offer the rigour of public examinations but they do allow teachers to evaluate both children and the learning experiences.

As our profession moves forward we must recognize the importance of teamwork and stop avoiding the issue. There are systems which can be used to assess such abilities and even if this were not so there is still a case to be made for including teamwork exercises within a teaching/learning program. What we must turn our attention to is the question of how we should build such a program and how progression can be ensured.

Teamwork exercises can take many forms and it is immediately apparent that they should not be the sole prerogative of technology teachers. Technology, however, can be the central focus for work which involves teachers from a variety of areas, cooperating as a team themselves and working with a larger number of children. My own research into such activities particularly when the timetable is suspended and the task pursued uninterrupted, indicates that children identify with the work, recognize it's relevance and put far more effort into it than in conventional curriculum and timetable structures (Denton, 1988). Factors to be considered in developing a policy in teamwork skills are: ensuring the policy is whole school; team size; team composition; time scale, and progression.

Teachers can incorporate teamwork building exercises within individual curriculum areas, however as it is a cross-curricula, skill development should be planned by cross-curricula teams. The question of progression also needs to be addressed. It is very clear that the "social and intellectual skills that children need in order to work together in a cooperative, egalitarian and supportive manner, need to be taught in a sustained and systematic way" (Ghaye, 1986).

Start with simple, short term exercises

within normal teaching. Teams should be initially small (2-3) and self selected, this will increase the chances of children being able to cooperate and work together. As experience is gained, staff should attempt simple cross-curricula exercises, perhaps using adjacent rooms and again within the normal timetable. A science and English class could combine to tackle a task.

Team size can be slowly increased to perhaps a maximum of seven, so that children learn how to delegate and communicate in more difficult situations.

Whilst efficient teamwork can generate a "hothouse" effect for ideas and work, there is also the danger of the phenomenon termed "social loafing" emerging. This phenomenon has been described by many workers as a situation in which members of a group or team may relax their efforts (Harkins, 1987). The causes of this are complex but it is my experience that, providing the team is not made too large and the task is designed to offer relevance, it rarely arises. Team composition can be experimented with. In industry or commerce, individuals do not have choices as to who they work with; they need to learn how to get along with others. Children will naturally choose preferred friends. They need to be slowly helped to be able to work with children with whom they do not normally mix. This is stressful but children often make comments such as "I found it very difficult, but I could see why we were doing it." A key point is that we must tell children why we are organizing their learning as we do. Often this is not done.

Basic attention span theory has always been interrupted by teachers as meaning all lessons should be short. This simply does not apply when children operate in teams around a task. Provided the task has a perceived relevance, such as a simulated industrial or commercial setting, you will find that it provides an ever changing environment, which in turn satisfies attention span. Children can build a far higher degree of association with a task if they are not constantly disturbed by lesson changes. We can get far more out of them if we suspend the timetable and they will learn far more.

In researching this area, it has become very clear that teachers everywhere recognize the value of teamwork in learning experiences. Deeper analysis, however, shows that they rarely have a clear understanding of the nature of teamwork, how it can be developed, or how it may be assessed. The next stage of this research is to look deeper at the whole question of what makes an efficient and effective team, how we can assess this, how we can assess individuals' performance within the team, and how we can develop their ability to be effective team members.

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Do Hands-On, Technology-Based Activities Enhance Learning by Reinforcing Cognitive Knowledge and Retention?

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INTRODUCTION

Technology education has passed through explicit phases from manual training through manual arts through industrial arts, to contemporary programs in industry and technology. These phases have been based on different psychologies and therefore, have produced varied rationales. Since the 1900's, one common link has been that the field is purported to be an important part of general education and therefore, can provide a meaningful educational experience.

In St. Louis around 1870, Calvin Woodward decided that the most effective method to "...illustrate certain mechanical principles..." was to have his students construct models out of wood (Barlow, 1967, p.34). Woodward felt that this particular hands-on experience demonstrated a practical use for various engineering precepts. It was this reliance on objects, tools, and materials to teach mathematical and engineering theory that produced manual training and eventually, industrial arts ideology.

Industrial arts, though, evolved more into a discipline oriented toward developing skills for the skills themselves rather than developing a knowledge of industry. Hands-on activities included building projects that incorporated the learning of "...technical processes without conscious concern of the socio-cultural context in which they exist..." (Lauda & McCrory, 1986, p.28). In recent years, technology education has focused on the use of tools and materials to help students understand concepts in technology and its relationships to various areas of education.

In the transformation of curricula, the common denominator has remained hands-on experimental activities. Industrial arts has always used various projects to stimulate interest, develop skills, and increase learning. Technology education has continued to focus on hands-on activities and modified them, helping students become technologically literate by developing problem solving adaptation skills and a positive attitude toward technology (Martin, 1985). However, one might question the hands-on activity approach as an appropriate and effective basis for learning in industrial arts and technology education.

The purpose of this study was to determine if hands-on technology-based activities enhance learning among eighth grade students by reinforcing cognitive knowledge and improving retention. Generally, it was designed to find out if increases in knowledge and subject interest were greater for those students given the opportunity to reinforce learning through laboratory activities. Specifically, the study addressed the following questions:

1. Is there a significant, measurable, knowledge increase when technology-based hands-on activities are used to supplement regular classroom presentations? RESEARCH HYPOTHESIS #1: Students participating in a hands-on group assignment would have higher scores the day after instruction than students receiving an illustrated lecture.

RESEARCH HYPOTHESIS #2: Students participating in a hands-on group assignment would have higher scores (on a test given after two weeks) than students receiving an illustrated lecture.

2. Do these hands-on activities establish greater retention of information presented?

RESEARCH HYPOTHESIS #3:There would be no retention loss between the first and second post-test for the hands-on method of instruction.

RESEARCH HYPOTHESIS #4: There would be no retention loss between the first and second post-test for the illustrated lecture method of instruction.

BACKGROUND

Educational theory supporting psychomotor activities to aid cognitive growth had its origins in the 1700's. Though experiences were often part of personalized education, such as apprenticeships or trades passed from generation to generation, Jacque Rousseau and JoHann Heinrich Pestallozzi proposed that doing was not an end in itself, but a way of expanding learning (Barlow, 1967). Later, many theorists provided support in favor of learning experiences that allowed the student active involvement with the subject matter. Jean Piaget, who developed a continuum of cognitive development, believed that a child could construct a more permanent knowledge base by experiencing something rather than just being told (Schwebel, 1973).

John Dewey, known for his many innovative educational philosophies and support of industrial arts education, was of the strong opinion that experiences, specifically hands-on activities, were imperative in the educational process. Students could blend theory and practice, success and failure, and school and society into a mental foundation for future thought (1980). Furthermore, activities allowed them to see, raise, and seek out solutions for personal and motivational questions. Dewey believed, however, that teaching skill for skill's sake was "...illiberal and immoral" (1963, p. 260). His ideas concerning skill training in education are summarized as follows:

> The educator is to engage pupils in activities in such ways that while manual skill and technical efficiency are gained and immediate satisfaction found in the work, together with preparation for later usefulness, these things shall be subordinated to education -- that is, to intellectual results and the forming of a socialized disposition. (p. 197)

Dewey further commented that "...any mode of skill which is achieved with deepening of knowledge and perfecting of judgement is readily put to use in new situations and is under personal control" (p. 259).

Bruner (1966, p. 41), a supporter of varied learning experiences, stated that "...increasing the manipulability of a body of knowledge" creates both a physical and mental optimum learning structure and contended that physical operations create feedback of learning that allow children to see it happen. Lipson and Fischer (1983) sustained this reasoning, stating "Experiences without words are difficult to integrate, describe, and retrieve. Yet, words without experience tend to have limited meaning. The two reinforce each other and are defined by one another" (p.254). Martinez (1985) further explains this in saying that a student who is introduced to a concept such as walnut wood will grasp a different meaning than a student who actually uses walnut and experiences its properties firsthand.

Human memory has been the basis for much research and speculation on how information is processed, saved, and retrieved. Researchers have identified two types of memory: short term and long term. During the past ten years, developments in memory research identified four separate memories within the long and short term. Just as a computer requires different microchips to handle screen memory, printer memory, computer language, and so forth, Adams (1976) identified separate memories each for auditory, visual, tactile, and body motor functions. This implies that any information that more fully utilizes all four memories would be stronger and more easily retrieved. Craik and Lockhart (1972) believed that memory is reliant on the depth that information is processed by more memories and strengthens the learning potential. In their research, Boothby and Alverman (1984) found that visuals, used in conjunction with lecture material, increased comprehension and retention of information.

A myriad of studies were found that dealt with the cognitive, psychomotor, and affective domains. Many research combinations concerning the three domains were located, with the exception of those addressing the use of psychomotor activities to increase or enhance cognitive learning and affective attitudes and motivation. Clark (1967) studied physical performance as it related to both cognitive and psychomotor learning activities.

A review of literature revealed that technology education has a basis in using hands-on activities to relate concepts. Educational theorists have stated that hands-on activities or experiences can lead to greater cognitive gains. Previous research, however, has not addressed the cause and effect relationships between psychomotor activities and cognitive results; therein lies the basis of this study.

METHODOLOGY

The objective was to find out if any measurable knowledge increases occurred when hands-on technology-based activities were used to supplement regular classroom presentations. First, objectives and lesson plans for two separate teaching environments were developed by the instructor and validated by a team of educational and technical experts. Then, four eighth grade classes in industrial arts and math were selected to participate, as they were considered representative groups of students. The students were randomly divided into two groups. Duplicate enrollees were scheduled only once, resulting in a sample of 50 of 72 possible eighth grade students.

Two methods of instruction were used by one instructor in teaching a 40 minute technical concept on geodesic domes to the 50 students. Group A (25 students) received information through reading and a hands-on group assignment, while Group B (25 students) received information through reading and an illustrated lecture. The hands-on assignment involved the construction of a model geodesic dome, using straws and pipe cleaners, while the illustrated lecture used slides and transparencies to show examples of designs and construction. A post-test was administered the day following the lessons to determine cognitive gains of each group. Two weeks after the presentations, students were again given the post-test to measure retention levels. Post-test results were compared to test the hypotheses.

The testing instrument was developed using the objectives and information to be covered as guidelines for test questions. An effort was made to avoid creating a test that was only repetition of facts. While some questions did require simple fact recognition (for example: "Domes were used as early as...") other questions required mental calculations or thought (example: Which of the following is not an advantage of using triangles over rectangles?). Questions were pilot tested by administering them to a seventh grade reading class. A computer generated test-item analysis was completed to identify possible poor discriminators. A re-analysis of those questions resulted in one item being removed, leaving the total number of questions at 22. A Kudar-Richardson analysis (KR 20) calculated a coefficient of reliability of 0.618 for the first post-test scores.

After the first post-test scores were finalized, the average score of Group A and Group B was calculated based on the number of students in each group. These mean values were compared, (using the Statworks program for the Apple Macintosh computer,) to calculate an unpaired t-test. Two weeks later, the second post-test for each group was administered and the results were compared using an unpaired t-test of significance. In addition, the second post-test scores of each group were compared with the initial post-test scores, using a paired t-test, to specify knowledge retention for each group. The scores were tested at the .05 level of significance using critical values of statistical results based on 48 degrees of freedom (Hinkle, Wiersma, and Jurs, 1979).

FINDINGS AND DISCUSSION

Specific questions were posed to study the effectiveness of hands-on activities versus stand-alone classroom lecture presentations. The findings are illustrated in Tables 1 and 2.

TABLE 1
T-TEST COMPARISON OF THE MEANS FROM THE FIRST POST-TEST, NEXT DAY

Group	N	Mean	SD	DF	T	P

A (Hands-on Assignment)	25	14.52	2.74			
B (Illustrated Lecture)	25	11.88	3.02	48	3.24	.002

TABLE 2
T-TEST OF MEANS OF THE SECOND POST-TEST COMPARISON, AFTER TWO WEEKS

Group	N	Mean	SD	DF	T	P
A	25	13.76	2.91			
B	25	11.56	3.54	48	2.40	.020

QUESTION #1: Is there a significant, measurable knowledge increase when technology-based hands-on activities are used to supplement regular classroom presentations?

CONCLUSION: As shown in Tables 1 and 2, Group A had a greater score on both post-tests. From the statistical comparisons of Group A and Group B on post-test #1, it can be stated that there is a significant difference between learning with and without hands-on activities. The results suggest that organized psychomotor participation increases the learning of a given technological concept. It can be generalized that hands-on activities are effective learning experiences for any applicable concept.

QUESTION #2: Do hands-on activities establish greater retention of information presented?

CONCLUSION: As shown in Tables 3 and 4,

scores between post tests did not support any significant loss of knowledge for either Group A or Group B. It was concluded that both teaching methods were adequate to enable students to retain information they had learned. Group A did lose slightly more information after two weeks, but still had significantly more knowledge than Group B. It can be generalized that retention abilities are consistent for most individuals; therefore, if one student learns more than another student, he/she will retain more information over a period of time.

TABLE 3
T-TEST COMPARISON OF RETENTION, GROUP A

Post-test	N	Mean	SD	DF	T	P
Next day	25	14.52	2.74			
After two weeks	25	13.76	2.91	24	1.58	.127

TABLE 4
T-TEST COMPARISON OF RETENTION, GROUP B

Post-test	N	Mean	SD	DF	T	P
Next day	25	11.88	3.02			
After two weeks	25	11.56	3.54	24	.54	0.591

IMPLICATIONS AND RECOMMENDATIONS

The results of this research have significant implications for general education and specifically technology education. The results suggest that hands-on activities enhance cognitive learning. Previous studies neglected to address psychomotor effects on cognitive growth, even when many educational theorists, like Dewey, supported learning using psychomotor experiences. The results also suggest that technology education has a strong basis in learning theory in its use of hands-on activities to relate technological concepts. This is done in part by improving short and long term memory retention of information through greater use of visual, auditory, tactile, and motor memory storage areas of the brain.

The study is a foundation on which additional studies can construct a more concrete platform of support for the use of hands-on activities in all educational subject areas. To aid further research attempts, the author recommends:

1. other research utilizing various technology-based hands-on activities should be conducted to further delineate the findings of this study;
2. research should be completed using different age levels (K through 12) of subjects; and
3. research should be completed with regard to levels and degree of cognitive understanding, for example, analysis, synthesis, and evaluation.

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Journal of Technology Education
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Writing for Technology Education Publications

Len Litowitz(1)

Where should technology teachers submit manuscripts for publication? How will they be reviewed? What are their chances of being accepted for publication? How may the odds for acceptance be improved? This article answers these and other common questions about submitting manuscripts for publication in selected technology education publications. Henson's (1988) article in PHI DELTA KAPPAN entitled "Writing for Education Journals" prompted this survey.

A questionnaire containing nineteen items was adopted from Henson's (1988) model. Ten nationally/internationally distributed publications in technology education were identified and selected for analysis. The questionnaire was mailed to the editor of each publication in the spring of 1989. Editors were asked to respond to the questions provided and to return a copy of their most recent publication guidelines. All ten editors (100%) responded.

PUBLICATIONS SURVEYED

A brief description of the ten publications surveyed follows. Information regarding manuscript review procedures is provided along with an indication of each of the publication's target audience.

INDUSTRIAL EDUCATION magazine is written for educators in industrial/technical and vocational education departments at the secondary and post-secondary levels of instruction. Articles published are primarily technical in nature but may focus on administration or philosophy. Publication decisions are made by the editor in conjunction with assistant editors.

JOURNAL OF EPSILON PI TAU (JEPT) is the official publication of the Epsilon Pi Tau honorary fraternity for education in technology. Articles submitted to JEPT may focus on technical competence, research and scholarship, or social and professional efficiency. Historical and philosophical articles are sometimes included in JEPT. The journal uses a referee panel consisting of the editor and at least two referees from a national pool to determine publication decisions.

JOURNAL OF INDUSTRIAL TEACHER EDUCATION (JITE) is the official publication of the National Association of Industrial and Technical Teacher Educators. Most subscribers are faculty members at institutions of higher education. Clientele include teachers of industrial arts/technology education, trade and industrial education, technical education, and industrial and military training. The JITE provides an opportunity for publication of research findings and professional reports. Philosophical or conceptual articles and dissertation findings are also included. The journal uses a blind review process for refereed articles that includes at least three reviewers for each article subjected to review.

JOURNAL OF INDUSTRIAL TECHNOLOGY (JIT) is the official publication of the National Association of Industrial Technology. Subscribers include faculty at institutions of higher learning, industrial representatives and graduate and undergraduate industrial technology students. Articles are primarily technical in nature, but research findings and conceptual articles are also published. Manuscripts may be submitted for refereed or nonrefereed status. Refereed manuscripts are submitted for blind review by at least three referees and the journal's editor.

JOURNAL OF TECHNOLOGY EDUCATION (JTE) is co-sponsored by the Council on Technology Teacher Education and the International Technology Education Association. The JTE is directed primarily at technology teacher educators. The JTE provides a forum for scholarly discussion on topics related to technology education. Manuscripts focus on technology education research, theory, and practice. In addition JTE publishes comprehensive literature reviews, guest articles, reactions to previously published articles, book reviews, and editorials. The JTE uses a blind review process with manuscripts reviewed by at least three referees from an international editorial board.

SCHOOL SHOP magazine caters to persons professionally involved in industrial arts/technology education, industrial education, or education for trade and industry at all levels. Articles related to teaching techniques, innovative projects, laboratory or classroom administrative procedures, and contemporary issues are frequently published. Publication decisions are determined by the editor in conjunction with assistant editors.

TECHNICAL EDUCATION NEWS (TEN) publishes articles on all aspects of technical and occupational education, with emphasis on practical ideas that readers can apply to their own instructional situations. Included are manuscripts on curriculum development, teaching techniques, instructional media, exemplary programs, employment opportunities, research, and major trends and issues in the field. Publication decisions are determined by the editor in conjunction with assistant editors.

THE TECHNOLOGY TEACHER (TTT) is the official publication of the International Technology Education Association. It caters to technology educators at all levels on topics related to curriculum and technical content.

Philosophical and conceptual articles are also included. Publication decisions are determined by the consensus of a blind review panel consisting of at least three assistant editors from a national pool.

(TECHNOLOGY, INNOVATION, & ENTREPRENEURSHIP FOR STUDENTS) TIES magazine is a publication of Drexel University and is supported by industrial sponsorship. This publication is for teachers interested in increasing the technological literacy of their students. TIES articles should promote the understanding of technological concepts, traditions, and impacts. Articles on classroom innovation, invention, entrepreneurship, and problem solving are frequently published. Publication decisions are determined by the editorial staff of TIES magazine.

VOCATIONAL EDUCATION JOURNAL (VEJ) focuses on articles which discuss current issues in vocational education, technological and social trends, and promising practices, programs, and products. Articles frequently relate to one of eight themes announced each March for the next publishing year. Publication decisions are determined by the editor in conjunction with members of the editorial and publications committee. Publication decisions are based not only on quality, but on including a mix of articles in each issue.

FINDINGS

Responses from publication editors to the questionnaire are provided in Figure 1. The ten publications surveyed varied greatly in their characteristics. Major differences in characteristics can be attributed to the following facts:

- Each of the publications deals with different aspects of technology education and caters to different audiences.
- Some publications focus specifically on research findings while others stress ar-

ticles related to classroom activities and curriculum.

- At least half of the publications use a national panel of referees while editors and staff members determine the publication decisions for other publications.
- Some publications are geared toward secondary school teachers while others serve teacher educators almost exclusively.
- Several of the publications serve an audience much larger than technology education.

FIGURE 1. Characteristics of selected technology education journals

Manuscript acceptance rates ranged from a low of 5% to a high of 75% with a mean acceptance rate of 44% for the seven publications that provided a usable response to this question. These acceptance rates can be somewhat deceiving because some publications solicit articles while others do not. Editors of publications that provided theme issues commented that the percentage of acceptance for theme articles was greater than their typical acceptance rate.

The number of issues published per year ranged from two to ten. There did not appear to be any correlation between the number of issues published yearly and the acceptance rate of the various publications. For instance, THE TECHNOLOGY TEACHER published ten issues yearly but accepted only about 35% of all manuscripts submitted for publication. Conversely, the JOURNAL OF INDUSTRIAL TECHNOLOGY published four issues yearly but accepted about 75% of all manuscripts submitted for review.

The number of weeks required to receive notification of a publication decision varied between five and fourteen with an average of ten weeks. There did not appear to be a relationship between the amount of time it took to receive notification of a publication decision and whether the publication used a national review panel or reviewed manuscripts "in house." Publications that did not utilize a referee pool sometimes took longer to provide a publication decision than those using such a panel.

There was no clear relationship between the number of issues published yearly and the amount of time it took for an accepted manuscript to appear in print. SCHOOL SHOP published ten issues yearly but required an average of twelve months for accepted manuscripts to appear in print. Yet, the JOURNAL OF EPSILON PI TAU, which published two issues yearly, reported an average of only four months to publish accepted manuscripts.

Writing styles were consistent among the various publications with most requiring the American Psychological Association (APA) writing style. Three publications did not require any specific writing style, and one publication required the Gregg Reference Manual. Most editors also indicated that their publications accepted dot matrix printed manuscripts, although some mentioned that it was not preferred. Several editors indicated that photographs and other visual media had no effect on publication decisions for their particular journals, while others indicated that such media did have a possible or definite positive effect. Most publications that indicated visual media to have a positive effect emphasized curriculum or content specific articles. Lastly, most editors indicated that they welcomed query letters or telephone calls. Some stated that query letters were more appropriate than telephone calls.

HELPFUL HINTS FOR GETTING PUBLISHED

Editors seem to agree that there is no magic formula for authoring a publishable manuscript. Commitment on the part of the writer is probably the single most important attribute to successful publication. Still, commitment is not enough. The VOCATIONAL EDUCATION JOURNAL publication guidelines indicate that authors must: (a) have something important to say and (b) say it well.

Both criteria are equally essential to successful publication. Patrick Miller (1987), at the time he was serving as editor of the JOURNAL OF INDUSTRIAL TEACHER EDUCATION, described two types of manuscripts, which he came upon all too frequently: (a) those that had "not much to say but said acceptably" and (b) those that had "much to say but said poorly." His observations reinforce the VOCATIONAL EDUCATION JOURNAL publication guideline statements. Publishable manuscripts must provide important messages in a well written manner.

Miller (1983), Hanlon (1987), and Wilkerson (1987) have each provided helpful suggestions for would-be authors. A summary of their suggestions includes the following:

1. Familiarize yourself with field related publications. By thoroughly reading several recent issues of a publication, it is possible to obtain a feeling for the flavor of that publication. Knowing the types of articles that publications frequently include and the audience they cater to should help to determine the appropriate publication for your manuscript.

2. Obtain a copy of the editorial guidelines for publications you wish to consider. These guidelines can help you avoid simple errors in writing style and format. They often contain additional information such as preferred length of the manuscript and specific editorial procedures.

3. Write your manuscript as simply and sequentially as possible. Lack of focus

and organization are common causes of manuscript rejection.

4. Check to be sure that your manuscript has "face validity." Like everyone else, editors and reviewers are subject to first impressions. Eliminating all grammatical, typographical, and spelling errors prior to submitting your manuscript will add to its face validity. The quality of a manuscript's appearance can also have an impact on the reviewer's first impression. Only quality photocopies of manuscripts should be submitted for review in addition to one original copy. Dot matrix print, while accepted by many publications, should be avoided if letter quality print can be provided.

5. Submit a manuscript to only one publication at a time. Ethical considerations dictate that a manuscript should appear in only one nationally recognized publication. By submitting to only one publication at a time, you avoid an excess of editorial comments and the embarrassment of having to choose between publications in the event of multiple acceptance.

6. Have professional colleagues review your manuscript prior to submitting it for publication. The many helpful comments which can be provided by colleagues' critical reviews may save you much time and frustration in the long run.

7. Write letters of inquiry to publication editors regarding potential topics you may be considering. Most editors welcome query letters and appreciate the opportunity to serve as a sounding board for potential manuscript topics.

8. Consider writing an article for a theme issue of a particular publication. Al-

most half of the publications surveyed provided one or more theme issues throughout the year. By authoring a timely article on an upcoming theme topic, your chances of acceptance should be increased.

9. Understand the review process for the publication to which you choose to submit your manuscript. A generic manuscript review process flow chart is provided in Figure 2.

10. Have patience! The time it takes to carry a manuscript from its original conception through the actual publication is often in excess of one year. Patience is a necessary virtue for publication in journals and magazines.

CONCLUSION

Potential authors should attempt to match each of their manuscripts to an appropriate publication. The audience for whom the manuscript is written, nature of the audience, and the appropriateness of the manuscript to a certain publication appear to be the most crucial concerns. Other important considerations may be the timeliness of the manuscript, the extent and method by which the manuscript will be reviewed, circulation size of the publication, and the publication's acceptance rate. A careful review of these characteristics prior to submission can save much valuable time and effort on the part of the author.

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Journal of Technology Education

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The Relationship of Technology To Science and the Teaching of Technology

Rustum Roy(1)

INTRODUCTION

TECHNOLOGY EDUCATION NEGLECTED

"Technology" as parallel subject matter to "science" has never found any major place in our K-12 system. This is due to the enormous confusion surrounding the question of the relationships between the icon-words "Science" and "Technology." In the American public's belief system, "Science" is a uniform good. The American credo affirms "more scientific research" is certain to be good for the nation. In economic terms, it fails to distinguish between a "consumption good" and an "investment good." Without any thought or reflection, the U.S. public and its leaders base actions on the proposition that the supply of new "basic science" is infinite, that science leads to applied science which in turn leads to technology and jobs. ALL of which assumptions are now regarded as, almost certainly, egregious errors.

The U.S. attitude toward technology, on the other hand, is much more ambivalent. On the one hand, "high-tech" carries the same cachet as "science;" but technology as polluter, negligent cause of adverse health effects (from war to asbestos to "chemicals"), conjures up powerful negative images.

This situation was compounded by still a further mistake. This is the fundamental error made after World War II in America when victory was ascribed to the atom-bomb (less than one in a thousand in the population realized that Japan had offered surrender before the bomb), and the atom-bomb was hailed and celebrated as a product not of U.S. technology, but of physics!!! Thus was "science" ensconced in America's pantheon.

Finally, while "science" (now represented by its subdivisions of Chemistry, Physics and Biology) became firmly ensconced in the school system, vocational education carrying many other connotations was the only toehold which anything resembling "technology" had within the school system. Yet today it is possible that another historic shift will allow technology to be re-entered into mainstream K-12 education.

IMPENDING U.S. DECLINE

The accelerating economic decline in the U.S. will provide this opportunity. And the end of the American half-century is now clearly in sight. The opportunity to return to a measure of reality will never be greater. The awareness that the present U.S. "science-emphasis" approach has been a devastating failure for U.S. technology and the economy must be proclaimed and reinforced at every opportunity by anyone concerned about better technology education.

OPPORTUNITY AND RESPONSIBILITY

Those concerned with technology education face an enormous challenge. First, they must clarify the relationships between science and technology, and clarify especially the place of both in the context of the economy and the political life of the country. Second they must re-think, "de novo," how and what one would teach the AVERAGE CITIZEN about technology, and secondarily what should be taught about science.

The purpose of this paper is to describe the muddle resulting from this linguistic confusion, and to present some basic definitions and relationships among science, technology and society. In addition, we address the two questions of what average citizens need to know about science and about technology.

THE PRESENT MUDDLE

TECHNOLOGY RESCUES THE U.S. AND IS MISLABELED "SCIENCE"

For 45 years since World War II, U.S. policymakers have survived on a series of historical accidents. Victory in war paid totally unexpected dividends in its aftermath. The U.S. was the only country with an enormous industrial machine running full tilt. This industrial momentum, with its overcapacity and its energized youthful leadership became the technological pioneer and monopolist to the world. But it did so on a strongly tilted (even if temporarily so) playing field, and with no opposition. The most significant policy impact occurred without planning. The many brilliant scientists -- physicists and chemists -- who had been doing amateur engineering in Los Alamos, emerged into the civilian sector with the assertion that it was "American science (especially nuclear physics) which had won the war." In the euphoria of the victory, no one even bothered to challenge this utterly preposterous claim. It was no time to point out that Japan even had, in effect, surrendered before the bomb, and it had surrendered because of superior U.S. munitions production technology. The modern physics which was needed for the bomb had all been done in Germany. If such scientific advances had anything at all to do with making bombs, virtually any country could make them. If science conferred any advantage, Germany should have won hands down. Making nuclear bombs was an enormous technological achievement, based on the U.S. enormous technology base in power, people, and resources. Yet the historical fact remains that just as Jacob stole Esau's blessing by sleight of hand (Genesis

27:27-34), a much more serious stealing of the birthright (the affection of the U.S. public) of "technology" by "science" occurred in the late forties. This misrepresentation -- this golden fleecing a la Senator Proxmire of stealing the kudos due to technology -- has, does, and will, until rectified, cost the nation very dearly. Shapley and Roy (1983) dealt with the impact on national policy. This paper focuses next on the impact on education.

WHAT SCIENCE AND TECHNOLOGY DO WE NEED?

During the last year or two, all policy analysts have agreed that U.S. technology is in deep trouble. Yet, without exception, the national response to the failure of U.S. technology is to demand more "science." This obviously assumes the absurdity that more or better science in K-12 equals better technology in the U.S. Paul Hurd (1989), dean of U.S. science education, in an elegant analysis of what is wrong with the myriad analyses of what is wrong with American science education, goes down all the alleged failures of the American schools, point by point, to show that in almost all cases it was the allegation that was incorrect. And soon, therefore, we shall be correcting mistakes that had not occurred. His central claim is that the American society's "contract with the schools" was for certain "services." It was not that the schools had failed in that contract, but that American society had changed radically and now wanted entirely different "services." Instead of better doing what was apparently required in the old contract, he suggests that the prior question is "What does American society want from its school system?"

In today's economic and political climate, my view of the tasks which society would like to have its schools help with, if not "solve," includes, at least, the following:

1. Maintain the U.S. living standards, as perceived by the public and experienced by a majority of the population, as being "the highest in the world." WHATEVER education is correlated with that, will be acceptable to the electorate.
2. Produce recognizably high achievers in all fields of learning: technology, art, humanities, sports, and science, who will contribute to a sense of national pre-eminence.
3. Help in the "socialization" of the minority populations, especially urban blacks and the new Hispanic and Asian immigrants; i.e. find meaningful work for them and thereby integrate them into American society.
4. Help in management of the social crises attendant upon major national failures -- widespread use of drugs, family structure dissolution, and so forth.
5. Educate a sufficient number of citizens to participate in, manage, and lead a complex technology-overlain society.

Hurd's point is that many of these are NEW goals for the school system, and the old school system cannot possibly "succeed" at them. In any case, no school system can contribute much to their solution.

All this bears directly on the issue of science and technology education because the #1 issue to confront the American populace and it's leaders in the next decade will be the economic issue. Most analysts agree that the speed of decline of the U.S. in terms of gross national product per capita, world economic hegemony, and so forth can only accelerate for the next several years. (See summaries in Roy, 1989; Roy, 1987). Without question the most significant immediate new task for the schools (and colleges and churches) is to prepare U.S. citizens, ON THE AVERAGE to LOWER THEIR EXPECTATIONS, while keeping hope alive. This may also, of course, require the upper third of the population to be "schooled" to accept even steeper declines to restore some equity after the Reagan years. Even the most enlightened political leadership cannot get elected on such a platform of managing economic decline, even if the alternative is catastrophe. But they can lead, if and when the groundwork has been laid in schools and churches to create a constituency. This is the magnitude of the task confronting ALL educators. But it does have a specific bearing on science and technology education.

EDUCATING AMERICANS IN TECHNOLOGY (AND SCIENCE)

This imminent national economic decline will present all educators with a tremendous opportunity because, for the first time in 50 years, the citizen will turn to new solutions. Among these solutions, there is a chance to rationalize the gross imbalance in the U.S. in interest, funding, and so forth favoring "science" at the expense of engineering and technology. But these educators also face an immensely more difficult question: What should be the goals, sequence and scope of content in technology and science?

WHAT NEW GOALS?

It is astonishing, as Hurd (1989) points out, that there is so little agreement on what the goals and priorities of science and technology education should be. It is our view that the broadest goal surely must be to educate citizens to cope with their present world. This means that the core of the curriculum must include TECHNOLOGICAL LITERACY (as described below) for every citizen.

Another goal at the other end of the spectrum would be the preparation of the professional college educated scientist and engineer workforce (about 10-15% of the population). Their curriculum would resemble most closely the present college-bound science tracks in our schools.

In the middle there should be radically new curriculum options which would combine much more hands-on practical learning -- not far from present Technology Education curricula, but with more science. This would put technology alongside more abstract science in a new "Applied Science" emphasis. And this option should be perceived as an equally prestigious and difficult option as any college preparation curriculum.

WHAT NEW CONTENT?

CLARIFY DISTINCTIONS BETWEEN SCIENCE, TECHNOLOGY, AND STS EDUCATORS.

In ALL the sets of options, a major emphasis must be placed on correcting old mistakes in the national perceptions of what science is, what technology is, and how they are related.

A very effective way to make the distinction is to point out the three rather sharply separated human communities and their separate activities; scientists, engineers, and science-technology teachers. These distinctions have been well made by Harrison (1989). Similar distinctions must be made between the goals of science and technology. Baruch (1984) put it very well. For students, a tabular apposition of the characteristics of science and technology often achieves a firmer grasp of the distinctions than any argumentation. (See Table 1)

TABLE 1

SHORT FORM COMPARISON OF SCIENCE AND TECHNOLOGY

SCIENCE	TECHNOLOGY
Human study and understanding of nature (natural philosophy)	Human use of human and natural resources to attain a desirable goal. Obviously, technology is as old as human society: pottery bows and arrows, jewelry.
Observation and reflection was the main tool in classical science (partly for religious/ philosophical reasons). Modern science (300 years ago) added added experimentation	Empirical cut and try is the time tested method of technological advance. Technology is always part of nature + human + artifact system with manifold feedback.
Science is inherently reductionist (i.e. ilolate the portion of the universe for study) and can be done in complete isolataion with no feedback loops.	

MODERN SCIENCE MODERN TECHNOLOGY*

Universal	Strongly influenced by local environment
Precise	Fuzzy
Simple truths, equations concepts	Complex aggregate of complex information
Transfers all content a light, to all parts of the world	Takes years, and is pointed at targeted audience
A single individual can understand and utilize new advances	Needs an entire system (=culture) to utilize new science or technology
Transfers relatively easily	Transfer is very complex
Many cultures do it well	MIGHT be highly tuned to cultures that value cooperation and community over individuals

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* Gestation periods are 10-20 years

DEVELOP CLEAR PICTURE OF RELATION OF SCIENCE AND TECHNOLOGY.

Next we must deal with the RELATION of

science to technology. It is imperative to undo the flat-earth ("science leads to technology") syndrome all the way through. It must be made clear with dozens of examples, starting with Galileo, that technology more often leads to science than the other way around. The accurate description of the science and technology relation is:

1. Technology leads to science more often than science leads to technology.
2. Technology and science are not in the same hierarchical plane in human learning. Technology integrates science's results with half a dozen other inputs to reach a goal.
3. Teaching technology and about technology is important for all citizens, while science is an equally important addition for a small (10-15%) subset.

This topic has been developed in detail in other papers (See, for example Roy, 1989; Shapley & Roy, 1983).

STRATEGY: PEDAGOGY FROM THE OBVIOUS, INSTEAD OF THE OBSCURE

From time immemorial, communicating "techne" was the passing on from generation to generation of the most important stored up knowledge and wisdom about the most obvious, most common, most often encountered human contacts with those parts of reality which affect humans the most.

Each generation learned as much as possible about food, shelter, security, and so forth and passed it on to the next. For the last century, and rapidly increasingly over the last fifty years, school systems have attempted to teach ALL students ABOUT reality viewed from the particular formalism and stance of abstract science. This science is characterized by two key parameters; abstraction and mathematicization. These features are responsible for the power and rapid growth of science. They are at the same time responsible for its unintelligibility to, and lack of interest for, the vast majority of the population. Moreover, common sense and widespread human experience shows that the vast majority of citizens do NOT need much abstract science, and only modest quantification, to function very effectively, even in a highly technological society. The last President of the U.S., the chairpersons of most of our largest corporations, the leading playwrights, poets, and university presidents have very little knowledge of the level of science some now demand of ALL students.

A technology-focused curriculum would eschew abstraction for obviousness. Every citizen would be expected to know about those parts of contemporary human experience which are obvious to all, which affect ALL in daily living.

A simple algorithm to guide the choice of what to know, which can expand and deepen with advancing grade simply by going into greater detail, is to follow the activities of an average pupil through an average day. From the alarm clock, to the light switch, to the clothes worn, the rubber in the sneakers, to the stove heating water for coffee, to the car being driven to work, there is an infinite opportunity to use these objects and experiences for teaching technology and applied science, and DERIVATIVELY basic science. This "applied science" must become the NECESSARY CORE for all students, prior to being exposed to ANY abstract science. The beauty of using the same common human experience -- eating, getting dressed, driving -- is that they can be updated at each successive age level; and with increasing depth and sophistication, can form the connecting introduction to any part of physics, chemistry and biology. This is the technological literacy necessary for all citizens; it is also much better groundwork to make science more likely to be attractive to larger numbers.

THE NATURE OF KNOWLEDGE OF TECHNOLOGY AND SCIENCE

Larkin (1989) has stressed the hierarchical structure of knowledge within physics. This author (Roy, 1986) has made the case that many applied sciences, such as materials research, do not lie in the same hierarchical plane as the basic sciences like physics and mathematics. In other words, materials research cannot be sandwiched in between physics and chemistry. The integration of several subject matters or disciplines, including engineering disciplines, combined with the purposive nature of the work, puts applied sciences and engineering into a higher hierarchical plane than the scientific discipline. In analogous vein, technology is not a subject alongside physics and chemistry (See Figure 1). It includes science as one among many inputs (See Roy's TWO TREE THEORY in Shapley and Roy, 1983).

The idea that learning science is the necessary pre-cursor to learning technology is absurd. All of human history is proof. Indeed the U.S. Department of Defense has shown that specific, even "high tech" tasks can be taught well, without any science. The entry points into the system of learning about technology are manifold. Figure 1 shows different routes which may be employed.

FIGURE 1. Hierarchical structure of knowledge, showing that technology is not on the same level as the sciences.

For THE MEDIAN LEARNER, we believe that the STS route -- entering via the interest in the societal problem -- is best. Moreover, it is the only innovation in CONTENT proposed for alleviation of the so called math/science crisis. For a 10 percent minority of the population, entering via science (the present tradition in the U.S.) MAY be the most effective. But for a larger minority, the entry through hands-on technology may be the best. The U.S. has been losing out on the "brains in the fingertips" of the artisan the "techne-ologist" by overstressing the abstract conceptualization as the ONLY way to learn the science which is related to technology, and technology itself. The next section omits the traditional route of more and better schools and improved BETTER SCIENCE CURRICULA, and focuses instead on the new options.

THE NEW PEDAGOGIC STRATEGY: STS - TECHNOLOGY - SCIENCE

It is the author's contention that the entire student body being exposed to STS will benefit them in several ways:

1. Students will be much more informed and aware of the most significant current issues.
2. They will have been exposed to a method of critically analyzing such issues.
3. They will have been made aware of how technology affects their lives, and how they may interact with technology.
4. A higher percentage than at present may choose to enter engineering, some because they perceive it as a means of controlling their own futures.
5. A higher percentage will become interested in the scientific background behind the engineering, and this could result in more candidates for science degrees.

Thus the STS approach to "science" education has two separate benefits; making better educated citizens and possibly increasing enrollments in science and engineering.

The STS route can be summarized by Figure 2.

FIGURE 2. The STS route.

At the conceptual level, this technological literacy requires a knowledge and understanding of the key generalizations of STS, all thoroughly explicated through numerous examples involving national problems from global climate change to liver transplant allocations to high-tech flight from the U.S., and so forth.

To acquire technological competence in this culture, one can take the route through high school science. This is certainly appropriate as a part of this POTENTIALLY deeper understanding of technology culture for the 5-10 percent who will major in technical subjects in college. How technologically literate typical science graduates actually are, is not clear. Nor is it clear how much science is optimal at this level. What has been established as a result of the "new Math," "PSSC," and "Chemstudy" approaches, is that having more and more sophisticated courses in physics and chemistry in high school has been counterproductive. Moreover, AIP data show that the percentage of physics majors who took no physics in high school is rising and now approaching 25 percent. It would appear that BROADENING THE BASE OF SCIENCES taught in K-12, by requiring the applied sciences (earth, materials, and medical) is a strategy which has not been tried. Moreover, this has the intrinsic pedagogic rationale that learning science through contact with applied science is certainly invaluable in itself, and may make much better basic scientists also.

Finally we turn to the citizens who will use more technology and less science in their life's work; the factory workers and the repair/service persons of sophisticated machines from automobiles to copying machines.

What mix of traditional science and modified technological education courses is optimal? The need for students with this kind of training becomes apparent when the U.S. is compared, for example, with West Germany.

EDUCATING AMERICANS IN TECHNOLOGY

If the foregoing is an accurate, albeit necessarily qualitative and anecdotal description of the present situation of educating Americans about and in technology, it would call for several radical reforms in the entire structure and content of K-12 education in technology and science.

The major and substantive change should be in rectifying the gross and unnatural imbalance in all formal education towards abstraction and away from relevance and concreteness in all technical subject matter. This kind of change is necessary. This degree of abstraction from felt and experienced reality is what has isolated the entire culture of science and technology from the masses of U.S. citizens. Science must be re-reified -- lemons and scrubbing ammonia must be connected to pH, toasters and irons must lead through fuses to amps, volts and watts.

The metals, plastics, and glasses every human being uses must be the seedbed from which the periodic table and thermodynamics sprouts. Global climate issues daily reinforce the reality of the earth as a system from which can issue biodiversity, life forms, evolution, and so forth. Every illness, every pill, every surgical procedure, can serve as the "bait" for biology for another fraction of the students who have not responded to the abstract approach.

But, and this is of the utmost importance, it is not because one may entice more students into entering technology or science or "appreciating" them that this change must be made. It is much more fundamental than that. It is the re-positioning and replacement of science back into its place as one among many human activities, potentials, values, ideologies, and so forth. Moreover, it is this that will ultimately rescue basic science, which is quickly running out of things to study at a price the public (the only possible patron) is willing to pay. If science is not to become baroque, besides being broke, the bridges to the everyday world must be strengthened. Fortunately for the world, the replacement of the British-American Nobel-prize-dominated economies by the Japanese economy as the dominant economic force with its TECHNOLOGY-DRIVEN SCIENCE, will bring home the point to the masses. Einstein once commented that if a culture's pipes did not hold water, neither would their theories. Yet thousands of graduate students in physics, chemistry, and even regrettably in electrical engineering, would be baffled by Einstein's claim of the close connection between our technology and our science, because the reductionist paradigm has held that they can be paid from the public purse to do theoretical physics without any concern for their country's economic or technological base.

It is not appropriate here to try to develop and justify an optimum scope and sequence of the courses in science, technology, and STS, which could optimally educate the MEDIAN STUDENT. An appropriate mix of K-12 teachers, professors of education, and school administrators needs to be assembled to do just that. Yet, from the foregoing one can summarize some of the elements which should be present in any new curriculum for an STS and applied science approach to education of the median student. Listed below are some of the key content which would be brought together under any such curriculum. And Figure 3 provides a VERY VERY rough sketch of the kind of sequence one could imagine for educating Americans about and in TECHNOLOGY.

KEY ITEMS TO BE INCLUDED IN NEW CURRICULA

1. Require STS components throughout 6-12
   a. Distinction between science and technology
      Relation of science and technology to Society:STS
   b. Role of Science and Technology in the interaction of Science, Technology, and Global Society.
2. Introduce formal science via applied science courses (Materials, Earth, and Medical Science).
3. Require some "technology" of every student in parallel to the science requirement in junior and senior high.
4. Shift emphasis of special programs from very science-talented, to science-alienated (a fraction of whom are also talented).

IS STS OPTIONAL IN COLLEGE AND/OR HIGH SCHOOL?

The place of STS in formal education is slowly becoming clear. It is, as Figure 4 attempts to show, the interactive heart of general education. For fifty years the fissiparous dominant reductionist model, based on a misunderstanding of good science, has cut the heart out of general education by dividing it up among watertight disciplines.

FIGURE 3. Possible STS and technology education emphases in the new sequence

STS has emerged today as THE unifying (across the two-culture divide of S/T and the Humanities) force. It obviously also emerges as that central core of general education which is NOT handed over to a "discipline". In that respect, STS is a re-invention of the idea of the UNI-versity as a part, indeed the very intellectual core, of the Multi-versity.

FIGURE 4. STS has become the CORE of

integrative general education, thereby taking over the core function of the UNI-versity, but doing it within the MULTI-versity.

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Personal and Professional Needs of Technology Teachers

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INTRODUCTION

In 1987, the Research Committee of the International Technology Education Association (ITEA) initiated a study of the personal and professional needs of technology teachers. The Committee felt that the planning of educational programs for preservice and inservice technology teachers should be based on their needs, both personal and professional. Their rationale was that if teachers' needs were not met, teacher performance and educational effectiveness would suffer. Some needs can be addressed with educational solutions, others with changes in management, and still others by looking at factors of the teachers' lives that lie outside the professional arena. This needs assessment was organized on the basis of extrinsic and intrinsic factors in the workplace of the technology teacher.

After reviewing the survey responses from the technology teachers, the Committee decided to sample secondary school English, mathematics, and science teachers as well and compare the responses across fields. The Committee hypothesized that the needs of traditional academic teachers, technology teachers, and laboratory and nonlaboratory-setting teachers might differ. Unfortunately, the response to this second survey was insufficient to warrant such comparisons.

BACKGROUND

Existing literature identifies several major reasons for professional dissatisfaction on the part of educators. Liebes (1983) and Kreis and Milstein (1985) mention low enrollments, economic difficulties in education, and lack of sufficient professional opportunities for teachers as reasons for teachers' dissatisfaction in the profession and as affecting factors regarding ways in which their needs are not being met. In discussing the teachers' needs, these authors relate self-perception to needs fulfillment through work.

The Kreis and Milstein (1985) study focused on teacher job satisfaction using Maslow's hierarchical concepts. Their results indicated that teachers' needs fulfillment is not totally consistent with the hierarchical arrangement described by researchers such as: Maslow (1954); Porter (1963); Herzberg, Mausner, and Snyderman (1966, 1967); Argyris (1971); Hinrichs (1974); and Sergiovanni and Carver (1975). The Kreis and Milstein study results indicated there was a significant relationship between job satisfaction and needs fulfillment. However, the conclusion that job satisfaction is related to a hierarchical arrangement of needs was not supported. Their results suggested teachers seek to satisfy some of their needs outside of the school setting, and that job satisfaction occurs when teachers perceive that what they are getting from the job matches what they perceive as being needed from the job.

Kreis and Milstein also discussed major changes in society and teaching as reasons why the study outcomes differed from the findings of earlier research. They identify teacher activities such as disciplinary tasks, nonparticipative bureaucratic structures, changes in working conditions, differences in the personal characteristics of teachers, older work force, and little infusion of younger teachers as possible reasons for the perceived needs of teachers not being met in their professional lives.

Teachers spend a great deal of their time on nonteaching- related activities. Kreis and Milstein suggested that if the performance of schools is to improve, the needs of teachers must be addressed and satisfied within the professional arena of their lives. They concluded there should be diagnostic efforts to establish the needs of teachers as individuals followed by programs that address those needs.

Liebes' (1983) study suggested that teachers with experience undergo mid-life crises. She believes that the determining factor is the number of years of teaching experience rather than the age of the teacher. She also believes that if schools want to maintain quality educational programs, they must respond to these predictable crises by instituting active programs designed to address (on individual bases) stress and other career-related crises on the job. She suggested short-term career counseling and an ongoing participative staff development model. This model prescribes individual conferences with administrators and teachers, a job-environment match analysis, and a school-based staff development model in which team building, faculty needs assessments, participative design of staff development by teachers, and program evaluation are addressed. She believes that this kind of total program will provide strategies that will address large numbers of experienced teachers who are dissatisfied.

In yet another school of thought, Cardinelli (1980) indicated that teacher dissatisfaction is no different from any other professional dissatisfaction. The mid-life crisis syndrome is a normal, developmental, and generally predictable stage in adult life that occurs between roughly 30 and 50 years of age. He maintains that "burn-out" is not abnormal, and that the best way to combat it is to recognize it, plan for it, and implement strategies to help deal with it. Miller, Taylor, and Walker (1982) support this notion with their in-depth study of the aging teaching force.

PROCEDURES

A random sample of 1,000 secondary-level technology teachers was selected from the ITEA membership list. A questionnaire was designed, approved by the ITEA Board of Directors, and mailed to the teachers identified. A single follow-up questionnaire was sent to nonrespondents. Due to lack of funding, additional follow-up procedures were not possible.

RESULTS OF THE STUDY

The two mailings to the technology teachers resulted in the return of 357 usable questionnaires (36%). The number of usable responses to each question, however, varied. The findings are detailed in Tables 1 and 2 and are described below.

DEMOGRAPHICS

The largest category of respondents (32.2%) were senior high school teachers. About one-fifth (22.4%) indicated that they were junior high teachers. Another fifth (18.8%) indicated that they had a dual assignment at both junior and senior high school level. See Table 1.

The respondents were asked to specify their primary areas of teaching. The majority of respondents taught two or more of the areas listed -- communications, energy, production, transportation. Seventeen percent indicated "other" and wrote in specific areas. The areas most often mentioned in the category were professional (university), drafting, electronics, manufacturing, computer, and construction.

Nearly three-fourths (72.6%) of the respondents were from urban/suburban areas. Nearly sixty-three percent call their program "industrial arts," and 29.2% call their programs "technology education." A majority of the respondents (64.4%) indicated that they teach in unit shops; the most frequently named were woods, drafting, metals, and graphic arts. The remaining respondents teach in general shops or clusters.

TABLE 1
DEMOGRAPHIC DATA

Category	n	%
Teaching Level (n=357)		
Senior High	115	32.2
Junior High	80	22.4
Junior/Senior High	67	18.8
Post-Secondary	4	1.1
Teacher Education (University)	54	15.1
Industrial technology (University)	12	3.4
Other (e.g., administrators, etc.)	25	7.0

Areas of Teaching (n=376)		
Communications	74	19.7
Energy	18	4.8
Production	66	17.6
Transportation	16	4.3
Several of the above	137	36.4
Other (e.g., drafting, mechanical drawing, administration, construction, hot metal, computer, power tech., photography, cabinet making)	65	17.3
School Location (n=354)		
Urban/Metropolitan	118	33.3
Suburban	139	39.3
Rural	97	27.4
Program Type (n=353)		
Industrial Arts	221	62.6
Vocational	29	8.2

Technology Education	103	29.2
Program Classroom Type (n=345)		
Unit Shop	222	64.4
General Shop	75	21.7
Cluster	48	13.9
Age (n=356)		
35 or under	87	24.5
36 - 45	125	35.1
46 - 55	107	30.1
56 to over 65	37	10.3
Sex (n=356)		
Female	13	3.7
Male	343	96.4
Number of Years Teaching (n=354)		

0 - 10	84	23.7
11 - 23	166	46.9
14 - 35	99	28.0
Over 35	5	1.4

The category of teaching experience indicated by the largest proportion of respondents was "11 - 23 years." Fewer than four percent of the respondents were female.

JOB ENVIRONMENT

In general, the respondents were positive about their job environments. Two-thirds or more of the respondents indicated that the following job environment factors were "good" or "very good": Safety (80.0%), Job Security (74.1%), Working Hours (72.8%), Vacation/Leisure time (72.0)%, and Job Stability (70.4%). On the other hand, more than one-third of the respondents felt that two items were "poor" or "very poor": Incentives (38.4%) and Promotion (36.1%). See Table 2.

PROFESSIONAL IMAGE AND DEVELOPMENT

A large majority (85.4%) of the respondents rated their professional self-confidence "good" or "very good;" over three-fourths (78.4%) rated their self-esteem in these two categories. Though only 13.4% of the respondents indicated that their professional development was "poor" or "very poor," a substantial number felt that the funding for professional creativity (45.4%) and the funding for professional development (46.2%) was "poor" or "very poor."

JOB SATISFACTION, PROMOTION, AND SALARY

Over two-thirds of the respondents

(69.4%) rated their job as "good" or "very good." However, only about a third rated the Industrial Arts/Technology Education profession in these two positive categories. Nearly two-thirds (63.6%) felt that promotional opportunities were "poor" or "very poor." Roughly one-third (33.4%) of the respondents felt that their salary was "good" or "very good" while another third (34.0%) felt their salary was "poor" or "very poor." Over one-third (37.8%) had taken some action toward finding another job within the past two years.

TABLE 2
JOB ENVIRONMENT FACTORS

	Percent by Category				
Descriptor	Very Poor	Poor	Okay	Good	Very Good
Description of Job Environment					
Atmosphere (n=349)	1.7	7.4	22.9	39.8	28.1
Working hours (n=349)	1.1	2.3	23.8	44.1	28.7

Personal Safety (n=350)	0.0	4.9	15.1	35.7	44.3
Job security (n=348)	2.3	6.6	17.0	35.3	38.8
Job stability (n=354)	2.3	7.6	19.7	34.5	35.9
Salary (n=355)	3.9	16.1	33.8	33.8	12.4
Promotion (n=343)	13.4	22.7	30.3	22.7	10.8
Incentives (n=344)	12.8	25.6	36.3	18.3	7.0
Benefits (n=350)	2.3	11.1	27.1	45.2	14.3
Vacation/leisure time (n=347)	2.0	4.6	21.3	42.9	29.1
Facilities and equipment (n=354)	2.5	10.7	33.9	37.6	15.3
School-wide discipline (n=341)	2.1	12.6	23.5	43.1	18.7
Students' academic capabilities (n=342)	1.2	9.7	37.4	44.7	7.0
Stress level (n=337)	4.5	15.4	47.8	25.2	7.1

Boredom level (n=318)	6.6	13.2	44.0	26.1	10.1
Co-worker cooperation and support (n=348)	1.4	7.8	25.3	40.2	25.3
Administrative cooperation and support (n=349)	5.7	10.3	27.8	36.7	19.5
Guidance counselor support (n=324)	8.3	20.1	40.7	21.9	9.0
Community/parental support (n=325)	1.8	15.4	40.6	32.0	10.2
State Department of Education support (n=334)	10.5	20.4	29.6	26.6	12.9
Professional					
Prestige from the profession(n=354)	1.4	11.6	27.1	40.7	19.2
Professional self-esteem (n=351)	0.6	3.4	17.4	48.7	29.9

Professional self-confidence (n=350)	0.0	1.4	13.1	49.4	36.0
Familiarity with new national standards (n=350)	1.7	13.6	29.7	35.7	19.3
Professional Development					
Professional development support(n=340)	4.8	18.6	34.3	29.4	12.9
Opportunities for professional development (n=344)	2.9	17.4	31.1	32.3	16.3
Funding for professional development (n=344)	16.0	30.2	24.8	14.0	15.1
Opportunities for professional recognition (n=345)	4.0	21.2	40.3	23.8	10.7
Opportunities for professional creativity (n=344)	1.7	11.4	28.5	37.8	20.6
Funding for professional creativity (n=344)	16.2	39.2	26.8	14.5	3.3

Job Satisfaction Factors

Tried to find another job in past 2 years (n=349)	Yes	37.8	No	62.2	
Rating of job at present time (n=346)	1.2	4.3	25.1	46.3	23.1
Rating of the I.A./Tech. Ed. profession (n=344)	0.9	18.6	45.9	31.7	2.9

Promotion and Salary

Possibilities for promotion (n=339)	32.7	30.9	18.6	14.2	3.6
Possibilities for salary increases (n=347)	11.5	22.5	32.6	24.5	8.9

Acceptability of Alternatives to Promotion

Professional travel (n=324)	31.9	6.2	14.8	37.0	40.1

Summer pay for curriculum development (n=320)	2.8	5.3	11.9	39.3	40.7
Computers in lab (n=307)	3.9	6.2	17.9	28.7	43.3
Leadership opportunities (n=301)	0.3	4.7	23.9	35.2	35.9
Acceptability of Alternatives to Salary Increases					
Professional travel (n=276)	7.6	10.5	17.8	27.9	36.2
Summer pay for curriculum Development (n=270)	6.3	6.3	17.4	33.3	36.7
Computers in lab (n=261)	7.3	8.0	21.9	29.9	32.9
Leadership opportunities (n=264)	5.7	12.1	21.6	33.7	26.9

Respondents who felt that they had reached their limit in promotional opportunities or salary increases were asked to rate the acceptability of alternatives. As an alternative to promotion, over 70% of these respondents rated travel to professional meetings, summer pay for curriculum development, computers in the laboratory, and leadership opportunities as "good" or "very good" alternatives. Summer pay for curriculum development was rated as the most acceptable alternative of the four. Eighty percent rated it in one or the other of the top two categories.

Of those who felt that they had reached the top of their potential for salary, a lesser proportion found the alternatives to be acceptable. Nonetheless, the alternatives were found to be "good" or "very good" by more than 60% of the respondents. Again, summer pay for curriculum development was most acceptable with 70% rating this alternative to salary increases in one of the top two categories.

CONCLUSIONS

This survey presents information that indicates that technology teachers feel much more positively about themselves and their profession than is perceived through interaction, media, and professional meetings. The results of this study provide some evidence that teachers are positive about their field, professional image, working conditions, and that they are generally satisfied with their jobs. The respondents also seem to be open to nontraditional alternatives to salary increases and promotion if they have reached their perceived limit in these two areas.

Administrators should consider innovative alternatives for compensation, promotion, and recognition. They should also consider nontraditional practices to provide for the professional development and increased creativity of teachers.

RECOMMENDATIONS

Based on the findings several recommendations are offered for consideration. First, administrators should assess the personal and professional needs of local teachers. There is reason to believe that these needs may differ by discipline. Second, teachers and administrators should work cooperatively to provide resources to develop an ongoing program of professional development for teachers and and the programs they serve. Third, this study should be replicated using a sample that represents the total profession of technology teachers rather than only members of a professional association. It is quite likely that members of ITEA would differ significantly in their responses compared to the profession at large. Last, resources must be allocated to assure that adequate follow-up precedures can be implemented to assure representativeness. None of these recommendations are sufficient or complete in and of themselves, but in combination they may be enough to make a substantial difference in more effectively actualizing the personal/professional needs of technology teachers, which in turn should improve and enhance academic programs.

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1 Jule Dee Scarborough is Associate Professor, Northern Illinois University, DeKalb, Illinois. The author is indebted to David Bjorkquist, Jay Smink, Ernest Savage, Ed Pytlik, Fred Illott, and Andrew Schultz who also worked on this project.

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Tubal Cain and All That

Peter Wilkinson(1)

A new journal arrives in the mail and, I'm sorry to say, gets the same treatment as most of the others. That is to say, I quickly skim read for things which might be useful to me, and then finding nothing, file it with the others. ("Useful" at 3:30 p.m. on a Tuesday means something I can incorporate into my lesson tomorrow which will help a kid learn better). On this occasion I find myself more disappointed and irritated with this state of affairs than usual. Mainly this is because it reinforces an impression gathered when I attended my first ITEA Conference in Dallas. At that time I circulated madly and spoke to everyone I could pin into a corner, searching for ideas to bring a new relevancy and value to my own program and philosophy. Until the third day it was virtually impossible to find a teacher, a front-line-trenches genuine school teacher. Almost everyone was a "Teacher Educator" and almost all of them were advocating a similar philosophy -- get out of "projects" and into "problem solving" and "technology," as though both of these were new ideas and had not been taught before. "High-tech" was the new wave, with advanced computer hardware and software, CAD systems and robotics, etc. -- things generally far beyond the budget in my school. I heard comments about "turning your paint room into a clean room" and other strange things. I found it altogether very disappointing and somewhat frustrating. Where were the people like me at this ITEA conference? The answer came a day later, when real-life teachers arrived (you could tell them by the lack of blue pinstriped suits and the generally different air about them as they strolled through the foyer in groups supporting one another -- I knew the feeling well!).

When I met and talked to these people I found a very different reality. Many were still in the old "unit shops," had either an old Apple or no computers at all, and almost no budget. In short they were either worse off or in the same state as me. I asked about the "new" technology and they all laughed wryly, bitterly, and sometimes loud and long. The situation in most areas seems to be that there are a few schools in major centers, generally close to universities, where funds for "high tech" have been made available. But, they themselves were still managing with largely the same old equipment and the same minimal budgets as always, because there had simply been no injection of new funds to make changes and purchase new equipment. However I found that the failure to change to the newer ideas was invariably presumed to be the reluctance of teachers to "get out of the old comfortable rut." Somehow we have a reality gap, and politicians are being given a perfect cop-out.

It also seems to me that we have somehow lost the bridge between academic research, philosophical theorizing and the actual realities of the practice of teaching. Faculties of education used to be that bridge. They took the academic research and theory and operationalized it; they translated the theory into simple terms. They made it understandable and useable for the practitioner. Today I find the jargon almost unintelligible even with some 11 years of university education. I have no quarrel with jargon and am fully aware of its value both for a description and identification, but it seems that unless one is actively involved with a university, much of the research literature is almost totally incomprehensible. For most teachers the task of keeping totally abreast of current writing and research is almost impossible. Distance and workloads are just two of the factors involved. Am I right in thinking that "education" in universities has now truly become just one of the other "sciences" and so no longer needs a practical end goal -- research is done for the sake of pure research? This is obviously a legitimate philosophy, but someone had better form a new university department to do what faculties of education used to do -- bridge that gap. Thankfully there were also a few speakers at Dallas, the quartz-halogen highlights of those few days, who renewed me in my own search for excellence and spurred me on. I thank them with all my heart. I wish we could clone them.

This all came to my mind as I read your instructions for the submission of articles. To be frank I have no access to a system using either IBM, Macintosh or WordPerfect, I also can't give you anything in ASCII format. I have an old Apple of 10 year vintage -- and consider myself fortunate in that respect. It is in use most of the hours the school is open. Your writers, I'm afraid, will all have to be from universities or the richer (and urban?) school divisions - and what that will do to the whole cause of technology education in North America I leave to your imagination. If change is indeed necessary, and I believe we really can do better, the change will come about by field teachers being challenged and educated and inspired to do better. "Teacher educators" will have to do much more than write obscure journal articles to produce that inspiration -- however brilliant the research or quality of thought. They have to teach on the same planet as I -- to 32 grade eight students at 9:00 a.m. Monday morning.

I do know why I teach what I teach. I am fortunate in that we have been in a total multiple activity environment in Alberta since the 1960's. The curricular freedom built into that system has produced many innovative programs in this province, each bearing the individual stamp of the multitude of personalities and experiences involved. I have yet to see a better system for allowing teachers, professionals in their own right, to teach what they know and to inspire learning in their students.

In short, I teach children, taking individuals from where they are into new discoveries about themselves and the world. I use simulations and projects (so often decried in "scholarly" writings) and I usually find they work for me if I put enough effort and planning into them. I do hope that someone understands this plea - like all rural teachers I spend most of my teaching year without others in my specialization to "rap" with. It can get lonely and frustrating and I wonder what will happen if/when my own store of innovation dries up.

I am also very afraid that the profession once again is being "set-up" by politicians. It could be that I am growing too cynical but this is exactly what happened in the days of "Sputnik," remember? The reason given for the west being behind the USSR was that educators weren't doing what they should have been and education had to be fixed. Well now North America is "behind" Japan and WE are again expected to correct that situation by changing what WE do -- and without any extra funding this time you will notice. The task may well be forever outside of our control. Beware the revenge if we accept this precept, climb high on the bandwagon of "high tech" and yet, in the end, fail to restore the forever lost advantage.

Please find room in your journal to highlight some of the innovative real programs which are out there. We all have access to scholarly papers, and they certainly do have their crucial part to play, but I have yet to find a source describing new practical ideas actually working and the philosophies and personalities behind them. I want to be able to write and interact with those leaders in the classroom so that we can all build upon a shared experience and not continue to work alone, hunting and pecking in isolation.

Editor's note: the JTE does in fact accept manuscripts that are not on floppy disk (as we did this one). Since most people now use word processors for their work, it makes sense to take advantage of the "electronic" version of the manuscript, rather than rekeying it. So far, this approach is working very well... And exceptions will be made where necessary.

A number of excellent sources for new ideas directed toward secondary level classroom teachers are listed and described in Llitowitz's article, "Writing forTtechnology Education Publications," published elsewhere in this issue. The JTE is admittedly (and intentionally) directed more toward technology teacher educators than toward secondary technology educators.

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BOOK REVIEWS

Brand, Stewart. (1988). The Media Lab. New York: Penguin Books, $10 (Softcover), $20 (Hardcover), 264 Pp. (ISBN 0-1400.9701-5)

Reviewed by Joseph McCade(1)

Inventing the future at Massachusetts Institute of Technology (M.I.T.), the subtitle of Brand's book, reveals a good deal about its content. He describes the research efforts of some of the brightest people in the world at M.I.T.'s Media Lab. This unique facility allows these individuals to combine their talents with some of the world's most powerful computers in order to create radical developments in the field of communication. Yet, the true value of this book is not the articulate and understandable descriptions of exciting new technologies. Brand's insightful commentary concerning what the work of the Media Lab can reveal about the direction and impacts of these new technologies is the reader's true reward.

Brand quickly dispels the idea that the implications of the work of the Media Lab might be limited to communications. Reviewing the work of "information age" gurus, Brand reminds the reader of the economic importance of information-related activities. Information activities have now economically eclipsed activities in the agriculture, industry, and service sectors. Nicholas Negroponte, director of the Media Lab, believes that many of the communications modalities are converging. This will result, he predicts, in a major leap which will affect society as profoundly as did the printing press. Driving this technological spiral is the computer. Computers will not only empower this pending revolution, but will allow communication to become much more individualistic, more human.

Facilitated first by the conversion to analog electronic communication and later to digital communication, information is beginning to migrate freely from one media to another. In fact, these media are beginning to overlap one another. Brand interprets Negroponte's beliefs about the importance of CD-ROM, E-mail, personal computers, and VCRs, in relation to this convergence of communication technologies.

Brand's experience as founder and editor of the Whole Earth Catalog and the Whole Earth Review helped him to understand and appreciate technology. It is this perspective of technology which allows him to interpret the predictions of faculty and students of the Media Lab. These predictions involve how technologies will interact and direct the future.

Although it is only a small part of the rich content of the book, technology educators will probably find that the most meaningful part in Brand's book is the chapter on the Hennigan School. This chapter explains Seymour Papert's experiment with a school of the future. More than simply a computer-rich environment, the Hennigan School embodies an alternative learning philosophy. Those who have not read Papert's MINDSTORMS: CHILDREN, COMPUTERS AND POWERFUL IDEAS will find that doing so will greatly increase their understanding of Papert's philosophy, a philosophy of learning by discovery. Children are encouraged to guess, explore, experiment and imitate. Learning rather than teaching is the focus. This more natural learning style, one in which children follow their own interests, is believed to encourage the development of a love of learning.

The computer is combined with a programming language called Logo, which Papert developed for children. Logo is intended to take advantage of the child's interest in the computer to encourage him or her to learn by doing--to experiment. A powerful graphics-orientated programming language, Logo rewards the user quickly. This provides Papert's philosophy with a platform. With a minimum of help or intervention children are supposed to "learn" Logo.

Of extreme interest to technology educators is the addition of LEGO to the Logo learning system. The LEGO construction system is linked to the computer via an interface and controlled by a special version of Logo. With sensors and actuators, the LEGO/Logo combination is a complete computer control system. Although the LEGO/Logo system may be an attractive way to teach computer control, this use will almost certainly overlook the most significant attribute of the system. The discovery learning potential of the system as a means of involving students in problem solving and higher order thinking is foremost in Papert's mind. The LEGO/Logo system when linked with hands-on experiments holds tremendous potential for technology education. If educators can look beyond the attractive appearance of the hardware to an understanding of the philosophical purpose of the system, a step toward improved technology education could occur.

This book should be required reading for technology educators. It facilitates the literacy of the reader on leading edge technology. More importantly, Brand's book has the potential of beginning something our programs have needed for a long time -- a well-articulated perspective on how technology might influence the future.

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Forester, Tom. (1989). High-Tech Society: The Story of the Information Technology Revolution. Cambridge, MA: The MIT Press, $9.95 (Paperback), 320 Pp. (ISBN 0-262-56044-5)

Reviewed by Mark Snyder(1)

As we enter the final decade of the twentieth century, we find ourselves in a world of fierce competition to control the accelerating technologies of the information age. How did we arrive at this state of affairs? What are these technologies that are experiencing such immense growth and how do they work? Will all of this technological growth affect the way we live? Who will win the race for control of information technology? Such questions, which require answers ranging from very broad concepts to highly technical facts to predictions, are often asked of technology educators and are answered very effectively and perceptively by Australian information-studies professor Tom Forester in his book HIGH-TECH SOCIETY.

Forester has succeeded in meeting his objectives of writing a readable, comprehensive, and balanced book that describes the many facets of the technology revolution. His coverage of this topic provides an international schema from the outset by comparing how the high-tech snowball started rolling in the United States, Britain, Europe, and Japan.

Defining the "laws of microelectronics" in an intelligible manner, Forester explains how microchips are made and the impact that new chip manufacturing technologies have had in the development of computers. He further describes the role of microchips in the growth toward supercomputers, the forecasted fifth-generation computer, and artificial intelligence.

Other technologies about which Forester reports include digital technology and its various spinoffs in the "information-processing" industry, which are the result of combining computers, office products, and telecommunications systems. He also discusses facsimile, fiber optics, cellular radio, satellite communications, electronic mail services, videoconferencing, videotex, interactive video, personal computers, software, and a variety of potential technologies for the future.

Technology educators might feel threatened when they discover that a computer science professor at the Massachusetts Institute of Technology feels that computer literacy is "pure baloney" and that those "who use a computer only for the applications never need to learn how the technology works." However, in the section "Computers in the Classroom" Forester provides an array of opinions and viewpoints on the future of computer applications in education and reports on how the computer revolution has been handled in education by the United States, Great Britain, and France.

Forester continues by predicting the outlook for "factories of the future," "the electronic office," and the effect of information technologies on banking and retailing. He recognizes that "the Great American Job Machine... has created 20 million jobs in the service industries in the past 10 years" but is skeptical in regard to the number of service jobs that will be generated in the future. According to one source, "technology has a place - but by no means a dominant one - in the job market of the future." Forester points out that there will be other "key problems for high-tech society" such as high-tech crime and invasion of privacy.

The author concludes with his point of

view on the international competition for supremacy in information technologies. Forester pictures the United States at a point where it must change its focus from service industries back to manufacturing so it may redevelop its once strong industrial base and maintain itself in the world market. He also points out that Japan and Europe have serious internal problems that make the imminence of a United States decline questionable.

Forester offers a wealth of background information for all of the subtopics which he has chosen. He employs an impressive variety of secondary sources and includes a few selective technical illustrations and cartoons which contribute agreeably to the test. HIGH-TECH SOCIETY is exceptionally informative and provides an overview of the Technology Revolution that is nearly definitive and quite comprehensible when explaining highly technical information. This book will provide technology educators with answers to broad questions through detailed information presented in manageable terms.

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Miscellany

Scope of the JTE

The *Journal of Technology Education* provides a forum for scholarly discussion on topics relating to technology education. Manuscripts should focus on technology education philosophy, theory, or practice. In addition, the *Journal* publishes book reviews, editorials, guest articles, comprehensive literature reviews, and reactions to previously published articles.

Editorial Process

All manuscripts undergo a rigorous review process. Manuscripts that appear in the *Articles* section have been subjected to a blind review by three or more members of the editorial board. This process generally takes from four to six weeks, at which time authors are promptly notified of the status of their manuscript.

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1. Five copies of each manuscript should be submitted to: Mark Sanders, JTE Editor, 144 Smyth Hall, Virginia Tech, Blacksburg, VA 24061-0432 (703)231-6480.

2. All manuscripts must be double-spaced and must adhere strictly to the guidelines published in *Publication Guidelines of the American Psychological Association* (3rd Edition).

3. Manuscripts that are accepted for publication must be resubmitted (following any necessary revisions) both in hard copy and on a 3 1/2" or 5 1/4" floppy disk (either MS-DOS or Macintosh format). Moreover, the disk version must be in both the native word processor format (such as WordPerfect or MS Word) and in ASCII format.

4. Manuscripts for articles should generally be 15-20 pages in length. Book reviews, editorials, and reactions should be three to five manuscript pages.

5. Tables should be used only when data cannot be incorporated into the body of the text.

6. All figures and artwork must be submitted in camera-ready form.

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