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

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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 counterproductive 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 self-

sustaining? 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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