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AUTHOR Pucel, David J.
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ABSTRACT

Technological literacy may be defined as a knowledge of and competence in a technical method of achieving a practical purpose. This definition thus contains two components: technical (scientific) methods and practical purposes. Historically, industrial education has concentrated on the second component. The practical uses of technology should continue to be the central focus for curriculum development in industrial education; however, more effort should be placed on helping students develop a larger understanding of our technological society. One way for industrial teachers to accomplish this is to use the technological literacy approach (as opposed to the traditionally used project and occupational skills approaches) when designing their industrial education program. The technological literacy approach contains the following eight steps: determining the industrial occupations or occupational sector the course is to cover; developing or selecting a conceptualization of the key dimensions of the industrial area; identifying applicable technologies and available equipment; selecting sample projects to give students hands-on experiences; identifying other means of acquainting students with alternative technologies and applications; beginning the course with a presentation of the conceptualization of the industrial area; and relating all projects and other learning resources and activities to the conceptualization and key dimensions. (MN)

Technological Literacy: A Goal and Role for Secondary Industrial Education*

Introduction

As our society has become technologically more complex, the need for people to become technologically literate has become more apparent. For example, many schools now view computer literacy as being a fourth component of basic education, in addition to reading, writing and arithmetic. But computer literacy is not the only form of technological literacy that people must have. The challenge to educators is to develop functional programs within the secondary schools which will allow students to develop literacy regarding a growing diversity of technology. At the same time that the need for developing technological literacy has become more apparent, the role of industrial education (such as industrial arts and industrial technology education) is being questioned along with the roles of other practical arts and vocational education fields at the secondary level. Recent reports on excellence in education have essentially left these fields out of the proposed new master plans for secondary education (Education Commission of the States, 1983). Critics of industrial education often center their concerns around the perceived narrow focus of the industrial education programs and the accusation that the programs teach people antiquated skills rather than preparing young people to enter current technological society.

Industrial education, with its long history of teaching

* David J. Pucel, Professor of Vocational and Industrial Education, University of Minnesota, St. Paul, MN

technologies, can and should be a prime contributor to the development of technological literacy. It can do so with curriculum modifications which allow the field to maintain its integrity while meeting a new and expanding need in society. This paper presents a model for doing so, along with a rationale for why the model is appropriate.

How can secondary industrial education programs be designed to teach technological literacy? Before addressing this question, technological literacy and the role of industrial education must be defined. Technology, as defined by Webster, is "a technical (scientific) method of achieving a practical purpose". Literacy is defined as "the state of being literate", which includes having knowledge and competence in an area. For example, a person who is computer-literate has knowledge and competence in the area of computers.

Based on these definitions, technological literacy is defined here as a knowledge of and competence with a technical method of achieving a practical purpose. The definition includes knowledge of the technology and competence in its application. Webster defines knowledge as the "condition of knowing something with familiarity gained through experience and association." Association is defined as "the process of forming mental connections or bonds between sensations, ideas, or memories." When all of these definitions are integrated, it becomes apparent that the way to develop technological literacy through secondary industrial education programs is to provide students with a set of experiences regarding technology which can be associated with a larger set of ideas, sensations and memories. Since there are many forms of technology, and different ways of approaching it, the next question is, "What aspects of technology should be the focus of secondary industrial education programs?"

The definition of technology presented above contains two major components, each of which could be viewed as the primary focus for educational programming. They are:

1. Technical (scientific) methods
2. Practical purposes

Historically, industrial education has concentrated on the practical purposes portion of the definition. It has focused on the development of skills and knowledges related to the various industrial occupation sectors of the economy. In order to better understand this focus, we must review the origins of industrial education.

Industrial education evolved during the early 1900s as a response to the need to teach people how to apply the technology of the times in industry. As industry expanded, the application of technical methods to industrial processes also expanded. The average individual did not have the background or skills to assume productive roles within industry. Education was called upon to help address this problem.

An early attempt at addressing the problem was the manual training movement. Manual training concentrated on the technical methods or processes without concern for the application of those methods. The manual training movement was supported by a wide variety of people in the late 1800s. Most noteworthy were Dr. Calvin Woodward and Professor John D. Runkle who was the president of the Massachusetts Institute of Technology (MIT) at the time. Professor Runkle summarized the essential notion of manual training in the MIT catalogue of 1880-1881.

> "We abstract all the mechanical processes and manual arts and typical tools of the trades and occupations of men, arrange a systematic course of instruction in the same, and then incorporate it into our system of education. Thus without teaching any trade we teach the essential mechanical principles of all." (Mays, p. 36)

At that time, it was felt that generalizable industrial skills should be taught without concern for how they related to the practical purposes to which they might be applied in industry. It was believed that this would allow people to apply the skills they learned in school to a larger number of possible jobs, and that people would not have to commit themselves to an occupation too early in life. These arguments are very similar to those being debated by industrial educators today.

Although the manual training movement was influential in legitimizing the teaching of skills related to industrial processes in the schools, many people felt that it did more to highlight the problem than to provide an effective solution to the societal problem it was designed to address. Industry and policy makers began to realize that although the theory of manual training was impressive, it did not produce results. People prepared through manual training could not apply what they had learned to the real technical problems of business and industry. They lacked the ability to synthesize the general methods and to apply them to practical situations. Using the definition of technological literacy presented in this paper, they were not technologically literate.

It was at that point that industrial education as a concept evolved. The practical purpose aspect of the definition of technology surfaced as being very important. It became apparent that the applied aspects of technology became more meaningful and transferable if they were taught within a context similar to that in which people were going to be expected to apply the technology. In other words, it should be taught within a practical context.

The focus on applied technology is just as appropriate today as is was at the time of the industrial revolution. The primary difference between then and now is the types of technologies being used in industry. There is still a recognized need for people to be able to apply technology and for people to be able to generalize what they learn about technology to situations beyond the classroom. Applied technology is related to a context; it is not generic. The context dictates the application of the technology. If we wish to teach people how to use technology to accomplish an industrial purpose, then the focus should be on the industrial purpose and not generic technology.

For example, an industrial education graphics communication technology program would focus on the application of laser technology and computer technology to graphics. A physics course would concentrate on lasers and computers in a much more generic sense, without concern for a particular application. Therefore, in planning the graphics technology program, aspects of lasers and computers to be taught should be determined by their applications in graphics. On the other hand, the planning of the physics course would concentrate on a generic discussion of lasers and computers with some possible references to practical applications. One of those applications may be graphics, or none of them may be graphics. Industrial education must take care not to adopt the role of becoming solely a laboratory for providing examples of the application of generic technical methods (scientific principles) for science courses. If it does, the focus of acquainting people with the functional industrial uses of technology will be lost, and with it the unique aspect of industrial education. Although a general course on technological methods has a place in the schools, it should not be viewed as a replacement for industrial education. History has shown us that such a course does not make a person literate in the technology of industry.

In other words, industrial educators should continue to focus on teaching technical methods related to a selected set of practical purposes applicable to industry. A continuing challenge for secondary industrial education will be to clarify the practical purposes which should be the focus of industrial education. However, that debate has been going on for many years and will continue. Although it is a critical issue, it is not the focus of this discussion. This discussion focuses on how to design a technological literacy curriculum once an appropriate practical purpose has been identified.

Do not mistake the focus on practical purposes of technology presented above as an indication that values related to the application of technology are not important. They are important, and should be addressed throughout the educational programs of the schools. However, they should be taught while teaching about the practical applications of technological methods, and should not be the central focus of the curriculum.

The technological literacy approach to developing industrial education programs presented in this paper is based on the above definitions and the following assumptions.

1. The practical uses of technology in industry should continue to be the central focus for curriculum development in industrial education, as contrasted with adopting generic technological methods as the central focus.
2. Society and educational decision makers will perceive industrial education as having increased value if the student learning activities add to a larger understanding of our technological society, as contrasted with just teaching isolated activities in the form of projects.
3. Teachers are more likely to accept the need for changing what is done in the classroom if they feel that what they have done in the past can be modified to accomplish the new goal of technological literacy, as contrasted with being told what they have done in the past is incorrect, and that they must start over again.
4. Teachers must view the equipment they have available in the classroom and laboratory as vehicles for providing examples of the application of the technology of

industry, as contrasted with viewing it as needing to be equivalent of what is used in industry.

5. The experiential aspects of secondary industrial education will be more meaningful, and have a longer term impact on students, if they are placed within a conceptual (association) framework.

Assumptions one and two have already been discussed. The third assumption relates to a willingness of teachers to change their programs. If technology is to be integrated into secondary industrial education programs, individual teachers must be willing to modify their current curricula, or to adopt a new one. Experience has shown us that most teachers are not willing to give up what they have been doing to accept programs developed by others. Examples have been attempts to implement the American Industries Program developed by Stout State University, and the World of Construction and the World of Manufacturing programs developed at The Ohio State University. They have not been widely adopted by industrial education teachers. In order to adopt them, teachers would have had to make radical changes in how they taught and the goals they had. Even if it is desirable for teachers to make radical changes directed by someone or some group, it is unlikely that they will do so.

On the other hand, teachers are likely to modify their programs if they are provided with an appropriate rationale and model for doing so, particularly if the rationale and model compliment what they have been doing rather than being in opposition to what they have been doing. The technological literacy approach provides such a rationale and model.

The fourth assumption is regarding the types of equipment and materials that teachers can hope to have available in their classrooms and laboratories. When technology was relatively simple and inexpensive, many industrial educators assumed that they had to have the equipment of industry in their laboratories in order to have an effective program. This was based on the assumption that people should be taught using what they would actually use in industry. It has become clear that whether one believes or does not believe this is desirable, such an expectation is now unattainable. Industrial equipment is too expensive and is changing too rapidly to make it feasible to have a full range of current industrial equipment in the laboratories.

The fifth assumption is regarding the structure within which the practical purposes of technology should be taught in industrial education programs. If the purpose is to help people develop technological literacy through experience and associations, the programs must not only provide experiences with technology but conceptual anchors to which people can associate those experiences. Currently, most secondary industrial education teachers organize their programs using one of two approaches. They are:

1. The project approach (curriculum organized around learning activities or projects).
2. The job skills approach (curriculum organized around skills for performing an occupation).

In order to clearly understand the technological literacy approach, one must be able to differentiate it from these two approaches.

Project Approach

Teachers using the project approach usually plan their courses as follows.

1. They define the length of the course (e.g. 9 weeks, one semester, one hour per/day, two hours/day).
2. They search for projects related to the content area they are to teach which they feel students at that level could meaningfully complete.
3. They select projects which can be completed in the time devoted to the course.
4. They teach those components of the content area (e.g., graphic arts, manufacturing, transportation) related to those projects.

For example, if you were asked to teach a nine-week introductory graphic arts course using the project approach, you would go through the following process.

1. You would determine that you had nine weeks to teach people something about introductory graphic arts.
2. You would determine the types of projects which students could meaningfully complete related to graphic arts.
3. After selecting a number of projects, you would develop an outline for teaching each project. It would include the materials needed, a step-by-step procedure for developing the project, etc.
4. When the students come to class, you would teach each of the projects and the related information and techniques needed to complete them.

I am sure you recognize that this procedure is used by many industrial education teachers. When asked to integrate technology into their programs, teachers using this approach will select projects which utilize technology. Many, in fact, select the projects based on the availability of technology in the classroom. Therefore, students are introduced to limited components of technology which are associated with specific projects and which can be taught with the equipment available. However, they are not introduced to technology which is unavailable in the classroom or laboratory, and they are not shown how the component of technology taught adds to a broader concept of the industrial area. This approach does not lead to technological literacy. It leads to hands-on experience with what is needed to complete projects or to work with technology available.

Occupational Skills Approach

The second approach often used by secondary industrial educators is the job skills approach. That approach is based on the analysis of industrial occupations which people are being prepared to enter. Once the skills and knowledges needed to enter the occupation are identified, some of those skills and knowledges are taught. Most secondary industrial education programs are not long enough to teach the full range of skills needed to perform in an occupation. Therefore, a limited number of skills are selected and projects are selected as vehicles for teaching those skills. The skills selected are usually limited to those that can be taught with the equipment available. Using this approach, there is a central organizer around which the program is developed, an occupation. However, the skills and knowledges taught are again usually selected and limited to those that can be taught using what is available in the classroom and laboratory. Limiting what is taught to those skills that can be taught with the equipment in the laboratory does not lead to technological literacy. It leads to learning how to operate a given set of equipment to perform a limited number of job skills.

Technological Literacy Approach

The technological literacy approach to secondary industrial education curriculum addresses each of the five assumptions presented earlier. It allows people to have experiences with technology which go beyond those possible with the limited equipment and materials in the classroom. It can be used with occupational training programs as well as awareness and exploration programs. The primary goal of this approach is to use actual hands-on experiences with industrial skills and knowledges, supplemented by other learning resources, as a vehicle for the development of technological literacy about the variety of technologies associated with an industry. Using this approach a course would be developed using the following steps.

1. Determine the industrial occupations or occupational sector of the economy the course is to cover (e.g., graphic communications).
2. Develop, or select, a conceptualization of the key dimensions of the industrial area area (e.g., image generation, image storage).

3. Determine which technologies are applicable to the key dimensions of the industrial area with which students should become familiar (e.g., lasers, computers, telecommunications)
4. Determine what equipment is available, or could be obtained to provide students with hands-on experiences with each of the key dimensions.
5. Select sample projects which allow students to have hands-on experiences with each of the key dimensions utilizing the equipment and technology available in the classroom.
6. Identify other means of acquainting students with alternative technologies, or alternative applications of the technologies, which go beyond those available in the classroom regarding each of these key dimensions (e.g., field trips, video-tapes, vendor demonstrations).
7. Begin the course with a presentation of the conceptualization of the industrial area by presenting the key dimensions and how they are integrated together in the industrial area.
8. Relate all projects and other learning resources and activities to the conceptualization and the key dimensions.

The critical element to this approach is that one begins with a conceptualization of the key dimensions of the area to be taught, and then relates all classroom activities, and the technologies to be integrated, to those key dimensions. Teachers whould either develop such a conceptualization of their own, or select one from those available [e.g., Towers, Lux, and Ray (1966); Illinois Board of Education (1984)]. If this is done, when students leave the class, they not only have the limited skills and knowledges and familiarity with the appropriate technologies that can be taught in any one classroom or laboratory, but they have a framework within which to place new skills, knowledges and technologies regarding that industrial area in the future.

Figure 1 presents a sample of this approach applied to the field of graphic communications. It indicates the industrial

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Insert Figure 1 about here

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area from which the content is derived (graphic communications). It presents what the instructor perceives to be the three key dimensions of graphic communications. It indicates that the projects conducted in class relate to each of these three key dimensions. It shows that other learning experiences which go beyond the hands-on activities in the classroom and laboratory will be related to these key dimensions. It also indicates the types of technologies that the instructor feels need to be reflected in the projects and/or learning activities.

Notice, this approach does not argue against the concept of a project, or teaching subject matter related to occupational areas and skills. Projects could still be the primary vehicle for teaching, but the projects selected would be selected as representative of the key dimensions of the area (e.g., graphic communications, transportation). Projects using this approach become samples of how skills, knowledges and technology relate to the key dimensions of an industrial area. They are used as vehicles to build a broader conceptualization as contrasted with being the end goals themselves. Yet the focus is still on an industrial area and the practical purposes of the technology. The ability to use other learning vehicles to acquaint students with advanced technology makes it possible for teachers to focus on technological literacy without having to rely solely on the equipment available.

For example, teachers teaching graphic communications could not hope to have all of the graphic communications technology equipment available in industry. However, they may be able to obtain a micro-computer and a copy of a software program, such as The Newsroom or Printshop. That computer system could be used to generate images, convey images (on a CRT or on the printed page with a printer), and store the images (either on a computer disk or paper). On the other hand, maybe the only thing an instructor has available for generating an image is a typewriter, for reproducing the image is a mimeograph machine, and for storing the image is paper.

In both cases, what the instructor has available could be used to provide students with hands-on activity relating to the conceptualization of the industrial area. Those hands-on activities could be supplemented with field trips, video tapes, movies, guest speakers, vendor demonstrations, etc. to expand student experiences beyond hands-on experiences.

Regardless which of the these approaches is used, once teachers select a project, the actually teaching of the selected skills and knowledges that are required for that project should be taught precisely, and students should be expected to demonstrate that they can perform the skills. This helps to accomplish other goals important to industrial educators such as a concern for work habits, quality, etc. For example, if an instructor is going to use a computer with The Newsroom program to teach image generation, students should be expected to use the computer and the program correctly to produce a quality product. The technological literacy approach is compatible with industrial education goals of teaching students to produce quality work safely, with the proper tools and materials, using the correct procedures.

Summary

In summary, secondary industrial education should continue to focus on the role which society has defined for it, the teaching of skills and knowledges related to the practical application of appropriate technology to industrial occupations. However, in doing so, it should adopt an overriding goal of developing the technological literacy of students as well as providing students with hands-on experiences. This can effectively be done by first developing a conceptualization of the industrial area to be taught. The conceptualization should include the key dimensions of the area and the identification of the appropriate technologies related to it. Then, the skills and knowledges taught in a program should be taught within that conceptual structure and the key dimensions using the appropriate technology. Students should be provided with hands-on experience relative to each of the key dimensions using the limited equipment available in the classroom. Those limited experiences should be supplemented with other activities to acquaint students with other appropriate technologies that are used in business and industry to carry out each of the key dimensions that are not available in the classroom.

If teachers are taught this approach, it will allow them to address much of the criticism which they are currently receiving from the public and educational decision-makers. Those criticisms often center around the perceived narrow focus of the industrial education programs and the accusation that the programs teach people antiquated skills rather than preparing young people to enter current technological society. The key to this approach is to show such critics that hands-on experience is essential to technological literacy, and that a well-structured industrial education program can use limited hands-on experience as a basis for providing a much broader technological literacy.

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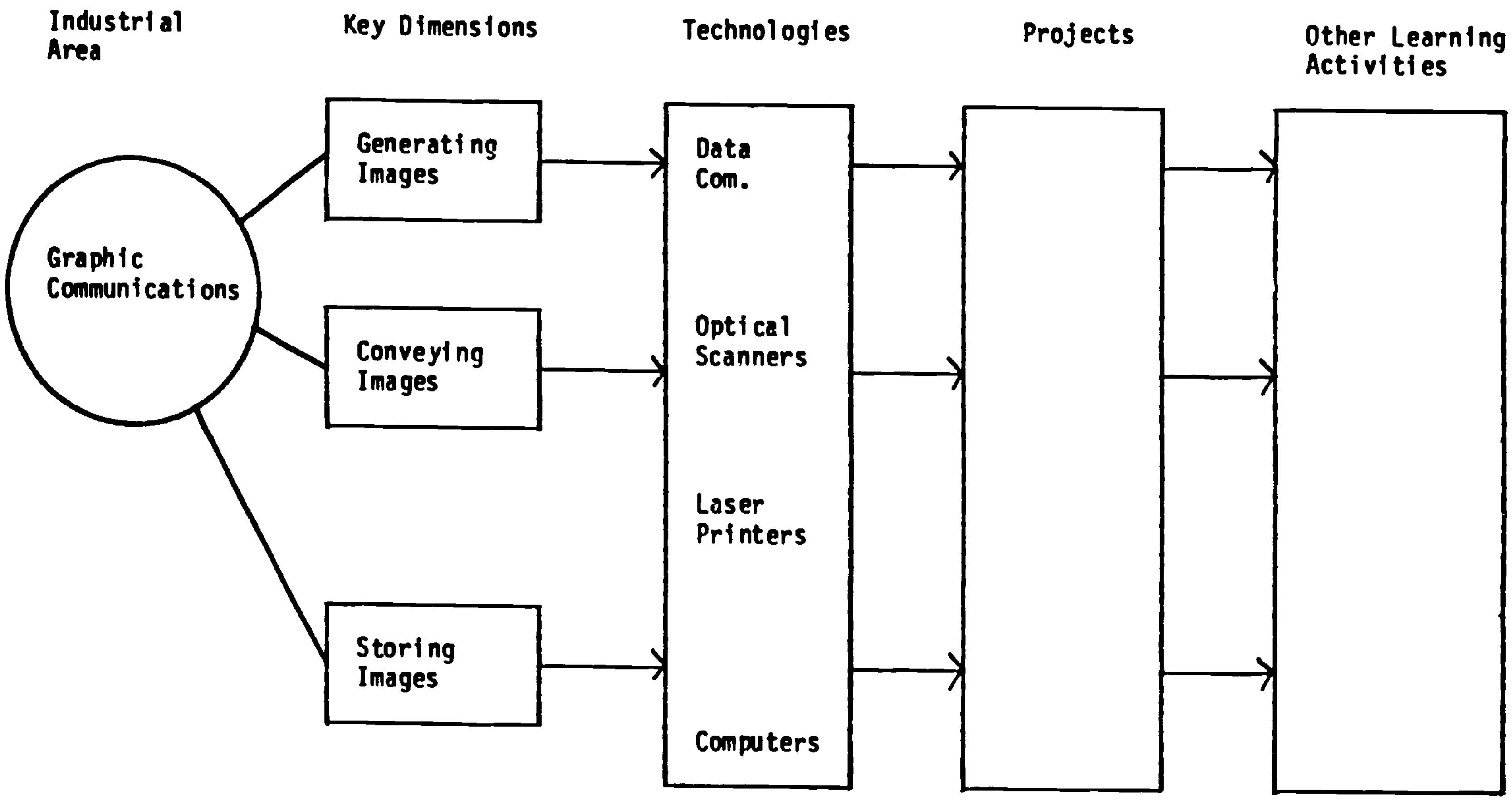

Figure 1. Sample of Technological Literacy Approach