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ABSTRACT

This paper discusses technology education, with a focus on agriculture. Discussion includes objectives of instruction; integrating technology into the curriculum; objectives in technology education, including 10 learning opportunities for achieving educational objectives; inservice technology education, including issues to address and problems for workshop attendees to solve cooperatively or individually; learning opportunities and activities for achieving objectives; and evaluation of pupils as integral to unit teaching. (Contains 10 references.) (AEF)

Integrating Technology into the Curriculum

By Marlow Ediger

INTEGRATING TECHNOLOGY INTO THE CURRICULUM

A study of technology is vital for pupils. Rapid changes are being made in technology and, perhaps, will increase even more rapidly in the future. A distinction needs to be made between technology education and educational technology. Technology education for pupils indicates how scientific endeavors have been used to make the world of work more pleasant and less tedious. Technology then uses discoveries in the world of science to improve human capabilities and work. At the work place then, individuals do less and less of the manual labor and receive the assistance of technology to become increasingly more productive and efficient. Educational technology emphasizes approaches that may be used to assist pupils to achieve more optimally in the class and school setting.

The focus here will be upon technology education which is designed by people to meet personal needs of human beings. Technology used is chosen and implemented by human beings. People also evaluate the effects of technology upon the natural environment, upon society, and upon themselves. Technology literacy is vital for each pupil as he/she progresses through the public school years. Objectives pertaining to technological literacy should stress the development, production, application, and assessment of technology use as knowledge, skills, and attitudinal ends for pupil attainment (See ITEA, 1996).

Objectives of Instruction

Each objective for pupil achievement in technology education should be carefully chosen as being vital for pupils to achieve. These ends should emphasize relevant knowledge, skills, and attitudinal objectives. Thus, the following guidelines may be followed when writing objectives for pupils to realize in technology education:

1. stresses the human made world, not the natural world.
2. emphasizes a doing approach instead of mainly knowing about something.
3. advocates solving of real technological problems, not merely raising questions by learners.
4. uses diverse strategies in solving problems, not inductive learning only.
5. arrives at solutions to problems, not explanations only or largely (See Wright, 1999).
6. diagnoses problems in the real world for solution rather than survey type questions.
7. proposes ways and means to develop a more humane life style rather than knowledge for its own sake.

8. achieves understandings in improving the human condition rather than stressing creativity for creativity sake.

9. accepts a philosophy of differentiating between technology and science.

10. makes use of science to further technological advances rather than using facts, concepts, and generalizations merely to do well in the testing domain.

Technology Education Integrated in the Curriculum

Unit teaching on farming presents a good example of integrating technology into thematic units of study. Pupils tend to like studying animals on the farm and related technology. Farms today are highly specialized such as in having cage layers for egg production. Generally, there are six to eight laying hens on one metal cage. A row of cages may be one fourth mile long. A very small producer may have 1,250 hens in cages. A large producer may have seven million hens laying eggs. The mash (feed) is augured into the laying house automatically from a storage bin outside the laying house(s) into where the troughs are located for feeding. Every forty minutes the mash feeder goes on and takes the feed automatically down the long rows of cages. Water flows along the metal cages to the separate troughs, from the mash, through gravity flow. Hens need much feed and water to produce well. Good layers will lay eggs at a 90 per cent rate per day. Eggs are made up of 75 per cent water (Conversation with Aldon Schroeder, January 5, 1999).

As a hen lays an egg, the egg gently rolls down the metal cage a few inches to where a conveyor belt is located. At the press of a button, at the end of the line, the eggs are brought to this location for packing. Eggs are packed automatically into boxes.

When growing up on a farm during the public school years 1934-1946, the writer's parents had a total of 300 laying hens in a hen house, no cages. Approximately 60 per cent of the hens laid eggs per day. Once a day, mash was carried in buckets to put into a feeder which had no automation. The mash was carried a distance of 40 yards. Water was pumped by hand once a day to fill the waterers for the 300 layers. Eggs were gathered by hand and placed in a bucket. The bucket was rather heavy toward the end after egg gathering from the nests in the hen house. Generally, one rooster was kept on each of two sides of the hen house holding the 300 hens. Roosters could become quite vicious in pecking at the back of one's legs as the eggs were gathered. Sometimes, a laying hen was a brooder hen, meaning that she sat on the eggs in the nest to keep them warm for hatching. A brooder was very protective of the eggs and would readily peck with force on a person's hand as the eggs were gathered from underneath.

The eggs in the bucket were taken to the basement of the house to be packed by hand into an egg crate, holding 30 dozen eggs. The egg crates were taken to a produce store, which no longer exist today, and sold. There were a lock of specific steps involved in egg production involving intensive labor when growing up on a farm on the writer's part. The laying hens roamed freely within a hen house and were not kept in small cages holding six to eight hens each. On nice days in winter, the laying hens could roam in the out of doors. There certainly was much freedom of movement then as compared to being a cage layer today.

With technology, the egg producer today can take care of many, many more layers that was true several decades ago. The following additional statements may be made of automation in egg production:

1. intensive labor does not exist. In fact, the producer has become a manger of producing eggs by observing that the equipment is working properly, including the electric lights coming on automatically at 5 AM so that the cage layers have a seventeen hour working day in regular and artificial light.
2. feed is brought to the farm by truck and is augerred into the holding bin outside the laying house.
3. eggs are picked up twice a week by a corporate company so that they may be candled, that is sorted as to size and quality, as well as placed into dozen and one and a half dozen cartons for retailing at the supermarket.
4. The producer, or farmer, oversees the egg laying operation, to see that all automation procedures are working in a satisfactory manner. The number of workers needed in a very large laying hen operation depends upon its size.
5. productivity of cage layers has increased tremendously from 1946 with its then labor intensive emphasis to the present with complete automaton and technology use.

Objectives in Technology Education

Objectives need to be selected carefully for pupil's to achieve in units on technology education. These thematic units integrate across different academic disciplines when it is profitable to do so, but not for the sake of content integration. Objectives need to be arranged sequentially for pupils to attain. Previous objectives achieved provide background information for the new stated objectives. Readiness for attaining the new objective should then be in evidence. Objectives should be challenging, but achievable. No pupil should fall between the slats in technology education. why? Technology permeates all facets of endeavors in the business world, in schools, in homes, and in society. Pupils who lack knowledge and skills in technology will be left behind in achievement in future progress. Thus, all pupils regardless of present achievement levels need to study and interact with thematic units involving technological education.

Learning opportunities to achieve objectives need to be

1. purposeful so that pupils perceive reasons for achieving in technology education.
2. interesting so that each pupil will be attentive and have an inward desire to learn.
3. meaningful in that a pupil perceives the content and skills to make sense and be of value.
4. on the present achievement level of each pupil with continuous optimal progress then being forthcoming.
5. based on teaching the class as a whole, small group work, and individual tasks for learners to be involved with.
6. engaging for pupils so that active learners, not passive recipients, are involved in thematic unit teaching involving technology.
7. selected on the basis of pupil's feeling they belong to a group, rather than feeling as isolates.
8. chosen with criteria that stress recognition of each pupil's attainment to meet esteem needs.
9. incorporate chances for learners to reflect upon what has been learned.
10. inculcate within the pupil skills to monitor the self in technology education achievement (Ediger, 1999, 112-115).

The scope of the thematic farm unit on egg production may be broadened to include milk production and technology. Thus, in today's dairy farms, the number of dairy cows on one farm has increased from seventeen when the writer grew up on a farm to 1,000 or more. Milking cows may be done then continuously throughout the twenty four hours of each day. Each cow may be milked three times a day to up productivity. When growing up on a farm, cows were milked by hand. The milk was then placed in to five to ten gallon cans to be separated into cream using a cream separator. The whole milk could also be sold when meeting Grade A Dairy requirements for human consumption. Today the milk goes directly from the cow being milked by machine through a plastic pipeline to a bulk milk tank, holding five thousand to ten thousand gallons of milk. The milk is cooled down immediately to 38 degrees Fahrenheit to prevent bacterial multiplication. Daily pickup by a truck containing a bulk milk tank is a requirement. The milk is vacuumed from the bulk tank in the dairy barn to the bulk tank on the truck. The milk is never touched by human hands as it leaves the dairy cows and goes to the bulk milk tank on the truck. The milk is hauled to a central place and pasteurized so it is safe for human consumption. The milk then goes automatically into gallon and quart containers to be delivered to and sold in supermarkets (Conversation with Wesley Ediger, November 26, 1999).

Inservice Education in Technology Education

Technology education is a somewhat new area to be emphasized in curriculum development. Thus, teachers and administrators need inservice education to develop a quality set of objectives, learning opportunities, and evaluation procedures for pupils in the school and classroom setting.

For a workshop in technology education, a theme is needed. The theme may be entitled "Thematic Units in an Integrated Technology Education Curriculum." Those involved in the workshop should be actively involved in its planning. A general session with all participants in a school may plan the goals, the learning opportunities, and the appraisal sections of the workshop. In the general session then, problems need to be selected to cover necessary ingredients in technology education. Problems such as the following may be selected with consultant leadership and assistance:

1. Which competencies are needed by learners to use scientific knowledge to confront technological development.
2. How has technology made the world of work easier and more enjoyable for human beings?
3. What needs to be done to increase use of technology to make the world a better place to live in?
4. How does technology affect the work of teachers, the business world, the work place, and the home setting?
5. Which ingredients should go into thematic unit development for implementation in the classroom and school settling?
6. How should pupils be grouped for instruction in technology education?
7. Which approach should be used to organize the technology curriculum?
8. What procedures should be used to appraise pupil achievement in technology education?
9. How can faculty meetings be wisely used to improve technology education?
10. What predictions are there to ascertain which direction technology education will go in the future? (See Ediger, 1999, 13-19).

There are ample problem areas for participants to choose from to work in committees or individually. Participants might then choose which committee to serve on. Choices should be made on perceived purpose in terms of how helpful the report of the committee will be to guide successful teaching and learning experiences in the classroom. Whichever committee is chosen to work in, there should be quality communication among committees during the workshop. Each committee needs to have feedback from the others.

Assuming that four participants decided upon working on committee number five above, which plans of thematic unit instruction might they ultimately decide upon to pursue with consultant assistance? A resource unit might then be developed for classroom use. The resource unit is a flexible device that has more experiences for pupils than what can be used. Why? The technology teacher might then choose, from among alternatives, what to stress in teaching and learning for a specific set of learners. Pupils taught on the same grade level differ much from each other from one school year to the next. How do they differ? Background knowledge, interests, purposes, and aptitudes will make for diverse levels of achievement in technology education. Objectives for instruction may then be selected, from among alternatives, that are included in the resource unit. The chosen objectives need to be on the present achievement level of learners. From that point, learners may be better able to make continuous progress in achieving demanding, but attainable objectives through quality learning opportunities. Vital objectives for pupils to achieve in agriculture might well be the following, involving heavy use of technology (Edgier, 2000, Chapter Ten):

1. Irrigating crop land. Irrigation equipment is expensive, but relatively easy for the farmer to use. Irrigation equipment now can be pulled with a tractor to arrive at the needed place so that farm crops may produce well. Generally on an average year, wheat yields can be increased from thirty to eighty bushels per acre with the use of irrigation. Wheat plants need water at the appropriate time. Drouth and dry weather can certainly hinder yields. To much rainfall also can flood large or small areas of crop land. With the increased yield, there is an opposite and equal reaction and that is cost of irrigation equipment. Technology, however, solves may problems. Tractors and irrigation equipment increase grain yields and make the world of work much easier than could possibly be imagined in earlier times. Data for the cost of an irrigation system can readily be obtained from an equipment dealer.

2. Use of pesticides. Insects can certainly damage yields much in grain production. Thus, over production of grasshoppers in summer may truly cut drown on soy bean yields. In a normal crop year, soy beans may produce sixty bushels per acre. With insect damage, the yield may be cut in half in a short time with pest involvement in eating young plants. Agricultural pesticides may be used to kill grasshoppers and other eaters of plants. The application of pesticides again represents and opposite and equal reaction in that grasshoppers may be killed immediately, but the environment may be hurt/hindered with the possibility of unclean drinking water. Pesticides should be used only in the amount recommended to avoid pollution through overuse. Thus,

technology has greatly assisted in reducing damage to crops from pesticides. Additional problems are left to solve. Problem solving is the heart of the technology curriculum as well as in life itself. Information on the use of farm chemicals may be obtained from a local County Farm Extension Agent.

3. Herbicide use. Weeds are always a problem to grain farmers. A nice looking field of young soy bean plants can be crowded out in a short time with cocklebur weeds. The cocklebur plants grow more rapidly then do soy beans and thus grow taller to take away sunlight from the neighboring soy bean plant. The rapidly growing cocklebur plant also takes the moisture and nutrients away from the soy bean plant. The latter then soon disappear. With herbicides, the cocklebur plants can be completely destroyed and appear to be burned up. Technology has worked wonders here. The cocklebur can be destroyed through spraying with a herbicide. The chemical mixture is contained in a tank and is mounted on wheels and pulled by a tractor with very minimal farmer effort, except in driving the tractor, properly serviced, pulling the herbicide filled tank. Schools of Agriculture at major universities have much information on use of farm chemicals. There are excellent video tapes available on many facets of farm agricultural production.

4. Application of commercial fertilizers. The use of commercial fertilizers has certainly increased farm yields much. In the eighteenth century, Benjamin Franklin remarked, "Why do farmers have to work so hard for so little?" These were the day of using the hand to scatter grain for seeding and using a scythe for cutting the scant crop yield. Today and for some time, there has been over production of major farm crops, as well as of livestock. Commercial fertilized has helped to double the crop yields in a twenty year period of time. When observing supermarkets in the United States, there is an over abundance of food items. Nothing is lacking, be it bread, meats, cereals, fruits, vegetables, among other food items.

Commercial fertilizers can be applied on farm fields readily without being labor intensive. If anahydrous ammonia is used, the tank again is located on rubber tires and can be pulled by tractor to wherever it is needed. The needed chemical, as determined by soil testing, can then be applied where needed to increase crop yields. The farmer does not guess which agricultural chemicals are lacking, since scientific testing can determine deficiencies and to what amount. Common chemicals lacking in soils include nitrogen, phosphorous, potash, sulfur, and lime. These chemicals need to be used in recommended amounts and thus prevent polluting the natural environment.

5. Use of modern farm equipment. When growing up on the farm, the writer helped with the use of draft horses to do many tasks involving farm work. However, draft horse use went out very, very quickly. Technology has provided the farmer with tractors that can pull five to six

shears to plow crop land after harvesting. Disking and harrowing of land, after plowing, is done with each of these two implements being thirty feet wide to do the tilling of the soil. All farm implements can be attached quickly, including the grain drill, to a three point hitch on a tractor. After attaching each farm implement to the tractor with a three point hitch, a lever is used to lift these implements up or into the ground as needed. The hydraulic lift does the work of lifting the implement. Tractors have air conditioned cabs, electric lights, power brakes, and power steering. When growing up on the farm, the writer would have thought somebody was writing about, "Buck Rogers in the Twenty Second Century," when writing novels about the present state of technology use in farming. In other words, this is saying that someone's imagination was getting away from him/her in the 1930s and 1940s.

Today technology has provided the farmer with a twenty-four row corn planter. Twenty four rows of corn or soy beans may be planted at one time as a tractor goes at the rate of five miles per hour in pulling the planter. The writer studies the Old Order Amish who plant one row at a time and this planter from the 1920s is pulled by a draft horse (See Ediger, 1999, 27-32).

Grain is harvested today in one operation with a self propelled combine which can have a cutting width of thirty feet. When growing upon on the farm, the writer's father had a combine pulled by a tractor which cut a twelve feet wide swath. Many farmers then had combines that cut a six to seven foot wide swath. Several farmers were still using the grain binder in the 1920s and 1930s which cut a six foot wide swath of wheat or oats and made into into bundles tied by twine. The bundles were then shocked by hand by placing eight bundles into one shock with the grain heads being skyward to increase the drying rate. Later, The bundles in each shock were pitched using a pitchfork onto a wagon pulled by a tractor. The bundles were then pitched into a threshing machine which separated the grain from the straw and chaff. The grain moved from the threshing machine onto a trailer and hauled to the storage bin on the farm. From the trailer to the storage bin, the grain was scooped by hand. My that was labor intensive indeed as compared to the modern combine of today with its air conditioned cab, power steering, electric lights, hydraulic lift, and power brakes! The grain is cut, goes into the bin on the combine, and is augured onto a truck, as the farmer keeps on cutting the grain. The truck driver unloads the grain into a storage bin using a grain auger with no shoveling of grain by hand! The electric motor on the grain auger can auger the grain for long distances, such as 100 feet, to reach its destination.

For truly hi-tech farming, a sensor may be purchased and attached to the modern combine. The sensor or yield monitor locates and maps where the crop yield is low and needs fertilizer application such as nitrogen, phosphorus, sulfur, and/or potash. A print-out is obtained which maps areas of high, moderate, and low yield areas when cutting grain. (See Klinkenborg, 1999). Soil tests may then be run to ascertain which chemicals are needed to bolster productivity in lower producing areas of the field where grain has been cut. Grain farming today is a large scale operation, and may involve 2,500 acres of wheat, as compared to 160 when the writer grew up on a farm (See Ediger, 1998, 26-30).

Learning Opportunities to Achieve Objectives

In addition to the objectives section of a resource unit as developed in a workshop for inservice education, the participants also need to deliberate and choose learning opportunities to achieve desired ends. The learning opportunities should provide for each pupil so that optimal achievement is possible. These activities should capture pupil attention so that as much learning as capabilities permit about technology education is in evidence. Thus, the learning opportunities and activities should

1. assist pupils to achieve main ideas and concepts. Vital facts to support each main idea and concept must be in evidence.
2. guide learners to analyze, synthesize, and evaluate subject matter acquired.
3. help pupils to relate ideas, not perceive isolated entities.
4. emphasize the level of application of content in ongoing units of study involving technology education.
5. develop habits of perseverance and curiosity.

A hands on approach in learning will stress concrete learning experiences such as excursions, experiments, construction activities, project methods of instruction, and making models. Semi-concrete experiences should also be used such as video-tapes, films, filmstrips, slides, CD ROMS, internet, world wide web, programmed learning, and multimedia approaches in teaching and learning. Quality abstract leaning opportunities include the use of textbooks, library books, pamphlets, and reference books, among others. Reading, writing, listening, and oral communication experiences stress the abstract phase of learning.

Evaluation as Integral to Unit Teaching

Evaluation of pupils achievement in unit teaching is a must. Teachers need to determine what pupils have learned in technology education. Quality appraisal procedures need to be in evidence. A variety of good procedures need to be carefully selected using appropriate criteria. Evaluation techniques may well include the following:

1. portfolios containing pupil products and processes.
2. teacher prepared test results from pupils.
3. quality criteria used to appraise concrete, semi-concrete, and abstract learnings of pupils.
4. rubric use emphasized to appraise hands on processes involving pupil technology learning.
5. state mandated and standardized testing to ascertain what pupils know and what is left to learn in technology education.

Evaluation procedures need to be valid and appraise what is relevant to achieve in technology education. Items 1 through 4 can be highly valid in that they may truly pinpoint pupil progress in technology learning. If valid, each of these approaches will pinpoint what is taught in ongoing lessons and units of technology education. Here, the evaluation procedures are locally developed to evaluate that which was taught. Item number five may not be as valid. The test items here need to be examined to ascertain if they truly pinpoint what pupils have been taught and have learned in the technology curriculum.

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