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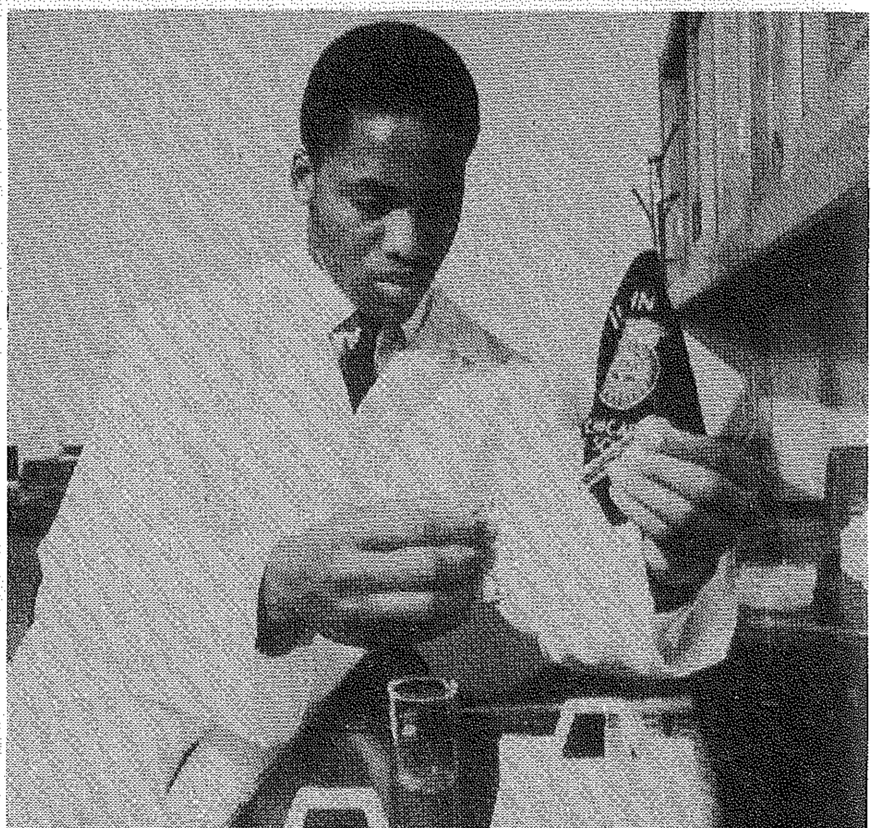

Teaching the Science of Agriculture

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Table of Contents

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Teaching the Science of Agriculture

BY DEAN SUTPHIN

Dr. Sutphin is Eastern Region Editor and associate professor of agricultural education at Cornell University.

Agriculture is an applied science that was the basis for science education in early American schools. True (1929) indicated that school gardens provided a laboratory to teach plant growth, botany and related science. Teachers used this approach to build on students' previous experiences, connecting new subject matter with a familiar content. The aquarian society of the time period depended on crops and other agricultural enterprises for both a primary food supply and as their income. The connection between science and agriculture was clear. And, so was the relevance of classroom and school laboratory instruction to real and practical aspects of daily living and to the needs of society. There were few distinctions between agricultural and science education until the Smith-Hughes Act of 1917, which linked agricultural education to vocational education. This act clearly separated science education from vocational agriculture. In essence, before the Smith-Hughes Act students were studying the science of agriculture as an integrated approach to learning.

Today, there is a movement in the agricultural education profession to teach the science of agriculture and to promote agriscience as a professional emphasis. This shift has similarities to earlier philosophies and raises some interesting questions. What does teaching the science of agriculture mean? What has led to this notion? What concepts, theories, and events support the idea? Is teaching the science of agriculture defensible in agricultural education? Program evolution that leads to progress rarely happens by chance, rather by careful consideration of circumstances and by addressing the relevant questions. Only then can significant energies be directed to accomplish realistic goals. Teaching the science of agriculture should be carefully considered by teachers before launching a program.

Defining the Science of Agriculture

The National Research Council (1988) suggested improvements in agricultural education by applying concepts from physical, chemical, and biological sciences to teach agriculture. With this model agriculture is a context for studying the sciences and a source of real-life examples. Less emphasis is given to the "how" of agriculture and more the "why", exploring and understanding the scientific principles that enable the industry of agriculture to flourish. These tenants effectively describe what is becoming known as the science of agriculture. Some agriculture programs are establishing separate courses on the science of agriculture, often referred to as agriscience. In some cases science credit is being given for these programs.

Driving Forces

The strongest impetus for teaching the science of agriculture within the profession seems to come from the 1988 Council report. The recommendations called for an updated curriculum, more scientific content, and relating the content to the increasingly scientific and technical nature of agriculture. These principles of a more scientific agricultural education have proven successful in several programs across the country, such as in Chicago and Philadelphia. These lighthouse programs give energy to more widespread implementation.

External forces outside of agricultural education also support teaching the science of agriculture. Carl Perkins legislation provides funds for new initiatives in vocational education that integrate academic and vocational education and create an articulated curriculum from high school to college. Carl Perkins grants are leading to agriscience-type programs in agricultural education. For example, a statewide program is being developed in New York State. Perkins legislation is currently the most significant source of federal grants for vocational programs, including agriculture programs.

Concurrently, the federal government and many state educational agencies have established goals that are compatible with Perkins legislation. For example, there is renewed emphasis on teaching science, critical thinking, problem solving, and the scientific method. Interdisciplinary learning and curriculum articulations are also high priorities.

Trends in local agriculture programs also suggest that teaching the science of agriculture is a viable and promising direction for agricultural education. A consistent decline in enrollments indicates a narrowing base of students who are interested in traditional agriculture programs. Most public schools have few students with an agricultural background or interest in production agriculture careers. Teaching the science of agriculture addresses the problem by appealing to a much wider range of students.→

Clearly, current trends, forces and factors support teaching the science of agriculture. However, it is unlikely that such efforts will be successful in the current educational environment without a strong, compelling conceptual base.

Conceptual Bases

Four conceptual bases for teaching the science of agriculture show there is a rationale for this approach. These include comprehensiveness, integration and connectiveness, experiential learning, and a disciplinary emphasis.

Comprehensiveness. A diverse curriculum with options that appeal to different student learning styles and interests creates a positive learning environment, one based on the democratic principle of choice. Support for a comprehensive school curriculum is traceable to the progressive movement in the 1920s when educators advocated social efficiency and empowerment of individuals to choose, rather than being subjected to imposed authority through a required curriculum. More recently there have been trends for separate vocational centers, tracking, and increased graduation requirements (Tanner and Tanner, 1980). These developments could limit comprehensiveness, if they lead to restricting course options that meet students' educational needs and interests. Teaching the science of agriculture provides another option to learn science and agriculture concurrently, breaking down the barriers between academic and practical studies. Eliot (1892) stressed that free electives allow individuals to discover and develop their talents. With the proper design agriscience may also count as a unit of science in some states, contributing even more to the concept of comprehensiveness.

Integration and connectiveness. Integrating biology, chemistry, and physical sciences, along with the social sciences, to address agriculturally related problems or issues helps students find meaning and relevancy to a sometimes fragmented and disjointed school curriculum. Agriculture provides a contextually rich learning environment. Problem solving, experimentation, and modeling used in teaching the science of agriculture require students to integrate what they have learned from across the school curriculum. For example, lessons on integrated pest management include concepts from the sciences (i.e., insects, mechanical and biological controls), mathematics (i.e., population modeling), social science(i.e., policy issues, government economics), agricultural and human nutrition (i.e., a safe food supply), and environmental studies (i.e., environmental risk management and pollution). The principles of integration and connectiveness go back to the late 1800s when the "Quincy System" advocated teaching reading, spelling and writing simultaneously. This was in response to a discovery by Parker, superintendent of schools, and the school board in Quincy, Massachusetts, that students were being taught memorized answers to pass state tests but could not connect subject matter to solve problems; they had no understanding of the thinking process. Similarly, today's educators are challenged by what Parker described in the late 1800s as a disconnected morass of facts and statistics in the school curriculum (Tanner and Tanner, 1990). The science of agriculture can provide a connective fabric to link subject matter across the curriculum.

Experimental learning. Learning from real-life experiences in a rich cultural context reduces narrowness and fragmentation of learning (Dewey, 1916). Education was to have a social purpose and the school community a direct effect on individual development, according to Dewey. Teaching the science of agriculture uses the school community as a teaching laboratory, socializing the learner in the democracy of their community where responsible decisions are explored with respect to the food supply, the environment, and society, thus helping students understand their role as citizens. Doing, however, may not result in learning, unless there is an educational purpose for the activities. In addition, laboratory notes and record keeping can be miseducative if low expectations, sloppy work, and low level skills become the norm. Thus the richness of experimental education advocated by Dewey in teaching the science of agriculture will not materialize unless the experiences are sufficiently high quality educational ones.

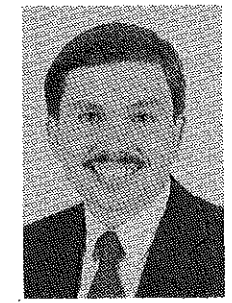
Disciplinary basis. Focusing on the sciences highlights the disciplinary basis for agricultural education. To maintain this focus, teachers should make a conscious effort to keep the sciences center stage and use laboratory exercises and activities in the school and community as a means of instruction. The concept of teaching the science of agriculture is a dramatic and important development in agricultural education. It is the single most powerful argument against critics who have come to view agriculture courses as a stream of activities. The skeptics see one judging contest after another, fund raising, cutting firewood, growing crops and similar "doing", "work" connected with little purposeful learning — certainly lacking any disciplinary merit in their view. Those who teach the science of agriculture will soon see an erosion of support for their claims if the curriculum has the appearance of activities driving the program rather than the disciplines. This is not to diminish the use of learning activities as a powerful teaching strategy, but an argument for putting these activities in a disciplinary perspective. The mix of disciplinary and experimental-based learning optimizes teaching effectiveness

Looking to the Future

Teaching the science of agriculture has historical roots in agricultural education, a conceptual

(Continued on Page 8)

Taking a Second Look



By Jeff Moss

Dr. Moss is visiting assistant professor of agricultural education at the University of Illinois.

Abundance may be the term which most aptly describes the quantity of curricula, instructional materials, textbooks, and media which have been recently produced to teach the subject of agriscience. Incorporating science into existing agriculture classes or adopting new agriscience courses is gaining momentum as a major reform of agricultural education programs in the secondary schools. If you are an advocate of agriscience reform, you will enjoy reading the articles in this issue describing successful programs which are helping to teach the science of agriculture. Considering what's available today for teaching agriscience, that wasn't developed or being used in agriculture programs five years ago, you are likely to conclude that things are looking good.

To make good things better often requires taking a second look at what's occurring, in this case, with teaching the science of agriculture. Today, that second look must be beyond the context of new agriscience curricula and focused on student learning in courses where we are teaching the science of agriculture. In many states, agriscience courses are fulfilling high school graduation requirements for science. In Illinois, a year-long Science Applications in Agriculture curriculum now satisfies one unit of university admission requirements in science. Are we doing, as many claim, a better job of helping students become scientifically literate by teaching science through agriculture? Are students being adequately prepared for college-level science through agriscience programs? Going directly to the bottom line, are students learning the science concepts and principles that we claim to be teaching in these new agriscience programs?

For the most part, the answers to these questions are still unknown. We can readily document what changes have occurred in the curriculum, but measuring the impact on student achievement in science needs more investigation. Fortunately, we don't have to wait for research studies to document our success or failure before taking action which will enhance student learning of science through agricultural applications. Hopefully, we heed the advice of science educators, who have a pretty good idea of how students best learn science, even if the lesson was learned the hard way.

How we teach new agriscience curricula is as important as what we teach. For guidance, we should base our teaching on principles which will help our success. Five such principles for effective science teaching are described in a recent publication of the American Association for the Advancement of Science entitled, *UPDATE, PROJECT 2061: Education for a Changing Future.* For background on PROJECT 2061 read the article by Trexler and Barrett in the January 1992 issue of *The Magazine.* Their article does an excellent job of describing the PROJECT 2061 reform movement and its pertinence to agricultural education.

The following principles for reform of science teaching have special significance for agriscience instruction, too. Applying these principles to instruction with the new agriscience teaching materials will help to ensure that students are learning the science of agriculture we teach. As a teacher of agriculture do you model the teaching practices listed with each principle?

Principles of Teaching

Teaching Should be Consistent With The Nature of Scientific Inquiry

- Start with Questions About Nature
- Engage Students Actively
- Concentrate on the Collection and Use of Evidence
- Provide Historical Perspectives
- Insist on Clear Expression
- Use a Team Approach
- Do Not Separate Knowing From Finding Out
- Deemphasize the Memorization of Technical Vocabulary

(Agri)Science Teaching Should Reflect Scientific Values

- Welcome Curiosity
- Reward Creativity
- Encourage A Spirit of Healthy Questioning
- Avoid Dogmatism
- Promote Aesthetic Responses

(Agri)Science Teaching Should Extend Beyond the School

Teaching (Agriscience) Should Take Its Time

Current teaching practices used in agricultural education (problem solving, demonstrations, supervised study) provide a good foundation for teaching agriscience, resulting in high student achievement in both science and agriculture. Applying the principles suggested by PROJECT 2061 will enhance our efforts and help to ensure that students leaving our programs are adequately prepared in science and agriculture.

(Continued on Page 8)

THEME ARTICLE

Bridging the Gap Between Agricultural and Science Education

BY LINDA WHENT

Ms. Whent is a lecturer in agricultural education at the University of California-Davis and program director of the Agriscience Institute and Outreach Program.

Is it possible that teachers can spend years teaching in the same school and have little or no idea of what their colleagues are doing in their classrooms? An agriculture teacher questioned about what is going on in the science department suggests that biology is taught only by following the biology textbook. A science teacher, questioned about what is taking place in the agriculture department, produces a vague reply about what students are learning in agriculture. From my involvement with the national AgriScience Institute and Outreach Program for the last two years, I have grown accustomed to hearing such comments from both science and agriculture teachers. With current educational trends mandating a move toward integration in education, consideration should be given to what barriers are present in teaching that promotes this isolation between subject areas, and subsequently, what educational models may be effective in breaking down these barriers.

There are agriculture teachers hesitating to change their traditional production agriculture classes and increase the science component in their agriculture curriculum. They are reluctant to attend an agriscience workshop because they believe their traditional agriculture program will be threatened by incorporating too much science into the curriculum. These same teachers may be afraid to start working closely with a science teacher at their school for fear of losing the agricultural emphasis of their program. Are these valid reasons not to start incorporating agriscience into agriculture programs across the nation? The increase of science and high technology in the agricultural industry, which demands more science background and science skills of its workforce, suggests they are not. Agriculture teachers who are not incorporating agriscience education into their curricula are not adequately preparing their students for the technical careers in the agricultural industry of today and the future. A continual challenge for teachers in agricultural education is to remain open to new ideas and concepts by keeping abreast of new agricultural knowledge, technologies, and skills. Barriers exist that make the challenge difficult. Often, agriculture teachers have not received the preparatory science courses necessary to qualify them to teach agriscience. Others have been out of school long enough that much of their science knowledge is forgotten or outdated. Continuing education through professional workshops is necessary in order to keep agriculture teachers up-to-date with agricultural research and new technologies. Fortunately, these workshops are now available through a special project of the National Council for Agricultural Education and the National FFA Foundation. The AgriScience Institute and Outreach Program is designed to bridge the gap between agricultural and science education. As many states now mandate integration in their educational curricula, the implementation of this program comes during a critical time in educational reform.

The AgriScience Program

The AgriScience Institute and Outreach program is testing a model to integrate agricultural and science education in a variety of geographical, ethnical, and rurally diverse high schools across the United States. The program model focuses on integrating agricultural and science education in two stages. The first stage involves forming collaborative science and agriculture teams to develop and test agriscience laboratories designed to address specific scientific principals related to real-life agricultural problems. The second phase of the AgriScience Program consists of Outreach Workshops. The workshops, being conducted during the summers of 1992 and 1993, are designed for agriculture and science teacher teams from the same high schools. →

AgriScience Institute participant tasting the Kimchee which was made in a soda bottle during the two-week-long institute.

An Inquiry Approach to Learning

One objective of the Program is to remove the barriers and confinements of teaching agriculture or science and to expose teachers to the idea of working together as facilitators, discovering knowledge of agriscience along with their students. The teachers, as well as the students, should become involved in the learning process. All of the experiments are designed to challenge students by providing a creative environment to explore a variety of agriscience experiments.

The laboratory experiments highlighted during the Outreach Workshops use Wisconsin Fast Plants and Bottle Biology as learning tools to present a wide variety of agriscience concepts. Fast Plants (Brassica rapa) complete their life cycle in 35 days and are an excellent resource for teaching plant science and genetics. Bottle Biology uses throwaway soda bottles, film canisters, tennis cans, and a variety of other containers to provide an inexpensive, hands-on approach to teaching agriscience laboratories in the classroom. During the Outreach Workshops, teachers are provided with hands-on examples that illustrate ways to introduce their students to a variety of biological principles through agricultural applications. The workshops employ an inquiry approach to learning where instead of students being provided with answers, they learn to ask questions, form hypotheses, and set up experiments in order to discover answers for themselves. Agriculture students comfortable with hands-on activities excel with this problem-solving approach to learning. Science students become excited by testing their own hypotheses and seeing the practical, real-world relationship of science principles and agricultural problems. Working in concert with science teachers, agriculture teachers strengthen their knowledge of science and increase the level of agriscience taught in their classrooms.

Sixth grade biology student studying the results of her Bottle Biology compost column experiment.

The AgriScience Institute

Last summer, 10 agriculture and science teacher teams came to the University of Wisconsin, Madison campus to attend a two-week AgriScience Institute. Teacher teams, working with university researchers, developed laboratories that challenge students to become actively involved in the agriscience research process. All the laboratory experiments have relevance to problems in the agricultural production industry, ranging from improving plant growth to testing water pollutants by using plant indicators.

During the institute, some marvelous things began to unfold. Most of the team members did not know each other well before the Institute. The Institute provided a forum where teachers from diverse backgrounds came together to share ideas, educational agendas, and other concerns. Teachers discovered similarities in curriculum and gained an understanding of what others were teaching. Science teachers learned how much hands-on science agriculture teachers were incorporating into their instruction and discovered the rich resource of materials and facilities agriculture teachers utilized. Agriculture teachers, in turn, discovered the wealth of scientific knowledge and resources that science teachers offer through their programs. All of the teachers left the Institute with a new attitude of openness and sharing.

The Success of Cooperation

During the fall of 1991, the teacher teams returned to their classrooms to field test the instructional materials they had developed in Wisconsin. The testing process further encouraged the development of a working relationship between the agriculture and science teachers. Several teams experienced great success from their new partnership. One science teacher, who taught college-bound students, started teaching classes in the agriculture department. The agriculture students (who considered themselves not academically successful) were excited and enthusiastic to have the science teacher (who taught the high-level science students) teaching units in their class. In exchange, the agriculture teacher started teaching agriscience units in the science class. The top science students were surprised to learn how much science was involved with agriculture. They discovered that agriculture was an interesting and challenging application of agriscience. The result was exhilarating. The whole school started to view the agriculture department as a viable, challenging academic program. The agriculture students were ignited by the AgriScience laboratories, and their self-esteem and academic success increased.

Another science teacher, working with the agriculture teacher from her school, asked her advanced science students to set up the →

laboratories in the AgriScience Instructional Materials for their local science fair. The students modified the experiments slightly to make them their own. Seven out of eight students won at the local science fair. All of these students went on to place at the regional level, and one student won at the state level. The science teacher was convinced that it was her exposure to the AgriScience laboratories, her introduction to the research approach to teaching science, and her cooperative relationship with an agriculture teacher that enabled her students to reach this level of success.

The Outreach

In March 1992 these teachers came to the University of California, Davis to attend a two-day meeting to prepare them for their national Outreach Workshops. During this meeting, the teachers shared their experiences of implementing the AgriScience laboratories into their curricula and their success with the learning-by-doing instructional approach.

The AgriScience Instructional Materials will be available only through the Outreach Workshops. During the summers of 1992 and 1993, 120 Outreach Workshops will be conducted in states across the nation. A major challenge in this program is to transfer the team approach of this model to other agriculture and science leaders. In order to encourage cooperation and sharing of facilities and ideas between science and agriculture teachers at the local level, the AgriScience program model was designed to recruit agriculture and science teacher teams from the same high school to the Outreach Workshops. After conducting three Outreach Workshops, one teacher in the program said she became renewed and rewarded by the response she had from teachers using these materials. She said that getting teachers excited about education again was one of the unexpected benefits of conducting the Outreach Workshops.

Scheduling of Outreach Workshops is currently underway. If you are interested in hosting an Outreach Workshop, contact Linda Whent, Program Director, Agricultural Education, Department of Applied Behavioral Science, University of California, Davis, Davis, CA 95616, (916) 752-3040. The AgriScience Institute and Outreach Program is funded by a grant from the W.K. Kellogg Foundation, through the National FFA Foundation, to the National Council for Agricultural Education. ■

about the cover ...

Stuart Wright, a student at the Chicago High School for Agricultural Sciences, performs a laboratory experiment. (Photo courtesy of Mike Wilson).

Teaching the Science ...

(Continued from Page 4)

basis to support it, and driving forces in and outside the profession that are promoting its development in agricultural education. Will the idea be successful? Teachers working within their individual school systems will likely determine the fate. Apart from individual initiative, teachers' success may depend on how successful teacher educators are in preparing future teachers and updating those currently teaching. State and local supervisors have leadership responsibilities for developing the concept of teaching the science of agriculture, if it meets students' instructional needs in their state and in local programs. Hurd and his associates (1980) said that the form of science education is determined by an individual teachers' beliefs, knowledge, and actions. In the final analysis, perhaps the same can be said of teaching the science of agriculture.

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Taking a Second Look

(Continued from Page 5)

There is a role for all of the profession to play in teaching the science of agriculture. As agriculture teachers, it's important to model the teaching practices associated with sound principles for teaching science. Supervisors of agricultural education programs can support this effort by planning inservice programs which will help teachers to master effective methods of teaching science. And, teacher educators must critically examine preservice programs to ensure that new teachers are adequately prepared for teaching agriscience. I challenge you to take a second look at the outcomes of teaching the science of agriculture. Are you confident that student achievement in science and agriculture is all that it should be? Let's look and see.

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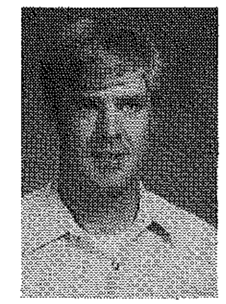
THEME ARTICLE

Teaching the Science of Agriculture — Animal Science



BY RICHARD HOOK

Mr. Hook is an agriculture teacher at Gordon High School, Gordon, Nebraska.

With the current emphasis on increasing science awareness in secondary schools, and the move to include more science-related curriculum in agricultural education, we as educators need to offer new and creative ideas to students to stimulate and develop meaningful science relationships. Here is a method I use to involve the high school science department with my agriculture classes and increase student awareness in animal science.

I consult with my local meat processor and explain that I need a teaching aid to supplement my animal science unit. In this instance, I need the complete gastro-intestinal tract from a beef cow. As soon as one is available, the processor calls me, and with a selected group of students, we're off. The students, with my supervision, remove the tract from the carcass. Since the GI tract is only used for rendering purposes, most packers are more than happy to let you have one for classroom purposes.

In our agricultural mechanics lab, we display the tract in descending order of use, from the throat membranes to the anus. I prefer to lay the tract on a large canvas tarp on the lab floor. This alleviates any mess on the floor, and the tarp can be easily hosed down. If this experiment is conducted in the cooler months of late fall, the tract will last several days without objectionable odor.

Once the tract is laid out, my feeds and nutrition class can see firsthand how the digestive process works. The four compartments of the stomach are opened and each examined for differences. The varying texture of feedstuff in the animal from rumen to abomasum, and how it is processed, is always of keen interest to students. Other parts of the tract that come under our scrutiny are the gall-bladder, the kidneys, the liver, the pancreas and the large and small intestines. My advanced livestock management class takes over in the afternoon, examining the tract for any evidence of illness or parasites. The liver is examined for abscesses and flukes. The reticulum is checked for hardware disease and the presence of magnet boluses. In our area of the Nebraska sandhills, sand impaction in the reticulum is fairly common, and students can see the implications of overgrazing a sandy pasture. Parasites such as roundworms in the intestinal tract are evident upon opening these areas up. Fecal flotations can also be done, and students can observe the eggs or cysts with a microscope.

My agriculture classes are not the only ones to benefit from this experience. Throughout the day, all of the biology and science classes from the high school and the junior high participate in this laboratory activity. Careful coordination and good cooperation with the science department enables science teachers to be on a digestive or anatomy unit in their classes at the same time. I utilize team teaching techniques with the other teachers to help answer questions and supplement their instructional process.

This year, I added a new area to my "teaching aid" concept by bringing in a complete female reproductive tract from a beef cow. Instead of using charts and overheads, I now show students what real fallopian tubes are, how the infundibulum receives the egg, and what an ovary is. By receiving several reproductive tracts from slaughter cows, I was able to show students a functional corpus luteum and a follicle ready to release an egg. The highlight of the year, however, was a reproductive tract complete with a three-month old calf. Students saw the developing calf, how it is encased in the placenta, the umbilical attachment, and how nutrients are transferred through caruncles and cotyledons. A unit on artificial insemination was also taught, and students were able to see how to thread an AI syringe through the cervix and trace the path of sperm to the ovary. Not only did our school science department utilize this visual aid, so did the health classes and the home economics department. Although the species are different, the human reproductive anatomy is essentially the same.

Teach the science of agriculture? It can easily be accomplished through the use of innovative and stimulating teaching aids coupled with relevant instruction. Interaction with other classes and departments paves the way for more meaningful activities and group involvement, which facilitates increased awareness and knowledge. An added bonus is the increased recognition toward the agriculture program. The universal comment from many teachers is, "Wow! I didn't think you did any science in agriculture classes." And the comment from many students was, "Boy, you do fun things in agriculture classes." I have even added enrollment to my program through these demonstrations. Teaching the science of agriculture can be fun and rewarding, and with some effort, can add new students to your program and dramatically change perceptions about agriculture programs in the public schools. ■

THEME ARTICLE

AgriScience Education — An Industry Perspective

BY DEBORAH J. SELFRIDGE and FRED H. STILLWAGEN

Ms. Selfridge and Mr. Stillwagen are in the Agricultural Research Division of American Cyanamid Company, Princeton, NJ.

The advent of a global society and the new era of biotechnology has given rise to new challenges for our science and agricultural education systems. For years industry used modern technology to increase production and improve its physical plants. However, with new changes and challenges facing industry the emphasis has shifted to education. Reformation or restructuring of the educational systems is a necessity to supply industry with properly trained workers for the future. At the same time companies are directing their efforts to retrain and update current workers for the continual changes that will occur.

In order to make science more relevant and representative of the workplace, the efforts of scientists and researchers are being used to bring the educational community together.

The industrial sector has recognized the importance of change in science education to make the sciences more visible and enticing for students. Recruitment in the industry has been an arduous and difficult task. With the lack of interest in the sciences the pool of qualified workers has decreased significantly. Thus, the difficulty of filling worker vacancies is compounded, and available jobs go unfilled each year. Without a stronger emphasis on the sciences, this trend will continue and hold back the development of much needed technological advances. To accomplish and expedite this monumental task all levels of education, government, and industry must work together. They must all move beyond their traditional roles and cooperate in generating new ideas, become more innovative, and increase support in all areas. In order to make science more relevant and representative of the workplace, the efforts of scientists and researchers are being used to bring the educational community together. These efforts will help provide high quality science education programs for students. It is imperative that these efforts include programs for grade school through college in order to maintain a continuity of science.

American Cyanamid Company has addressed this challenge through various activities to "Educate the Educators" for excellence in the classroom. To restructure science in the classroom we conduct a biotechnology workshop for agriculture and science teachers utilizing the hands-on concept. The teacher serves as the fundamental resource or catalyst in preparing students to become the scientists of tomorrow. Thus, to have self-confidence they must be properly prepared and trained to develop new skills, concepts, and materials which are infused into their curricula. Working directly with scientists in the laboratories at the Agricultural Research and Development facility, teachers perform protocols which can be integrated into the classroom. Some of the protocols have included Plant Tissue Culture, Recombinant DNA, Isolation of Plasmid DNA, Rearing Tobacco Worm Moths, In Vivo Bioassay for Baculovirus, Fermentation Ice Nucleating, Oil Degrading, Cryobiology, Electrophoresis, and Landfills in the Environment. Through these experiences teachers learn how biotechnology is affecting today's rapid changes and procedures in science. A personal follow-up at the schools of the participants has revealed infusion of the workshop protocols, concepts, and materials into their curricula. Also, an increase in student interest in science has been shown by an increase in enrollment. This has helped to precipitate a team approach to teaching science by the science and agriculture departments in many districts.

Important changes in teacher attitudes is evidenced by teacher requests and participation in workshops, inservice programs, sharing of ideas, more relevant curricula, and innovative ideas for student projects. These changes are also reflected by the students in the classroom who are able to use their hands and minds to experiment in a laboratory setting. Thus, science is now becoming relevant in the classroom.

This program has been presented in many states throughout the United States to teacher groups of all levels. The positive results show that an increase in teacher experiences will result in an increase in agriscience literacy. We have learned through experience that companies can and must work together in education activities at all levels. These joint ventures provide more expertise covering a wider range of industrial areas. American Cyanamid Company is presently working with local companies →

and school district administrators on an Education Interact Committee. Our purpose is to link research and development with local school districts. A pool of protocols designed by industrial scientists is being assembled for teachers to use in their classrooms. Also, a speakers bureau is being established with personnel from all companies volunteering their time and expertise. We have approached this industry/education partnership based on a three tier structure: elementary schools (grades K-5), middle schools (grades 6-8), and high schools (grades 9-12). This will assist school districts and enable agriculture and science teachers at all levels to develop curricula for continuity in the science programs.

The positive results show that an increase in teacher experiences will result in an increase in agriscience literacy. We have learned through experience that companies can and must work together in education activities at all levels.

A master list is comprised with all available programs, services, and resources supplied to all of the school districts for their usage. Thus, a school can utilize one or more companies individually or jointly to enhance its program needs. These programs and services are also made available to civic groups and community organizations.

This type of partnership will enable companies to have greater input, more follow-up, and accountability for program support and success. Corporations involved in this particular program include: Union Camp, American Cyanamid, AT&T, Rhone-Poulenc, VWR Scientific, Mobil R&D, Plasma Physics Laboratory, FMC, Cytogen Corporation, Bristol-Myers Squibb, General Electric, Astro Space Division, and Hydrocarbon Research.

This type of program prevails in many parts of the United States and is supported by many corporations in their respective locations. Additional companies which sponsor and support these programs include: DuPont, Hoechst Celanese, Union Carbide, Ciba-Geigy, Eastman Kodak, John Deere, Pioneer, as well as some companies in Japan and Europe. Due to the diversity in size and scope of companies, their level of participation in education/industry partnerships and programs will vary. In many areas a company adopts a school and gives them full support in science and math education.

Additional areas involving education which are gaining in corporate support include the following: summer employment for students and teachers, cooperative student employment during the school year, scholarship programs for students and teachers, educational programs for community groups, science awards programs, assistance for curriculum development, use of professional staff, use of plant facilities, workshops, presentations, and demonstrations.

Also, gaining support is the job-shadowing and hands-on experience in industrial laboratories where a student or teacher works or shadows a scientist for a day or more in the laboratory. In this way, they are able to develop a better understanding of needed skills and of current technology required for the job market. This coincides with volunteer mentoring programs where the scientist works with a student on a science project or a specific area of science.

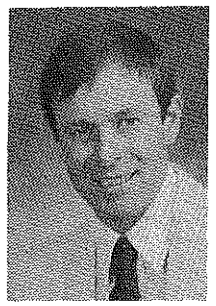
Agriculture and science fairs are ideal for students to interact with scientists involved with their project choice. These events are increasing for all grade levels and enable the students to explore and to be creative and innovative in their projects. They are challenged to think, their curiosity is aroused, and they become more inquisitive in seeking answers. The use of "what if ..." helps them reach solutions and results, just as in the laboratory setting. Caution must be used when setting up a science fair to minimize competition and increase interaction between students. The team concept will enable students to work together to solve problems. Judges should be selected from industry, if available, and should provide constructive comments to participants on their presentation and contents. This advice can be instrumental in helping students maintain their interest in science.

Also, gaining support is the job-shadowing and hands-on experience in industrial laboratories where a student or teacher works or shadows a scientist for a day or more in the laboratory.

A new direction or approach to high school science education is the Biotechnology Center established in a New York high school. This is one of three high schools in the United States that allows students to perform at an advanced level in DNA experiments. A few examples of student participation include: becoming familiar with the techniques that are used in making human insulin, interferon, and human growth hormone. The students perform recombinant DNA, splicing together different pieces of DNA. This center is also used for training teachers in technology. ■

THEME ARTICLE

Integrating Science and Agriculture



BY TOM DORMODY

Dr. Dormody is assistant professor of agricultural and extension education at New Mexico State University.

A national agriscience study at the secondary level during the 1990-91 school year focused on 1) agriculture teacher training and credentialing in science, 2) agriculture courses receiving science graduation credit, 3) agriscience laboratory facilities in agriculture programs, and 4) resource sharing between agriculture teachers and science departments. The goal was to remove misconceptions about teaching science in agriculture and about agriculture and science teacher partnerships. A mail questionnaire was answered by a random sample of about 240 agriculture teachers from 47 states. This summary can help agriculture teachers, science teachers, school administrators and boards of education understand and implement what others are doing in agriscience nationwide.

Science Training, Science Credentialing, and Science Credit

Many agriculture teachers are trained in science-related teaching methods. During preservice, 44% of the agriculture teachers in the study took courses that focused on science-related teaching methods. Of these, 20% took four or more of these courses. The number of agriculture teachers who have taken inservice courses or workshops on science-related teaching methods was much larger, (nearly two-thirds). In fact, more than 25% of the teachers had taken four or more inservice courses or workshops on science-related teaching methods.

Common worries among agriculture teachers are 1) being credentialed in science and 2) teaching agriculture courses receiving science credit, bringing agriculture programs closer to being absorbed by science departments. Are these worries justified? Almost half (47%) of the agriculture teachers in this study were credentialed in science. Although science credit is not a requirement for a strong agriscience program, 82 teachers from 33 of the 47 states received science credit for one of more agriculture courses in 1990-91. Only 27 teachers taught a non-agricultural science course. Seventeen of these teachers also received science credit for agriculture courses.

The study found that agriculture teachers credentialed in science were more likely to teach both agriculture courses for science credit and non-agricultural courses than those not credentialed in science. Also, more agriculture teachers who were not credentialed in science taught agriculture courses receiving science credit but no science courses (24) than science courses and no agriculture courses for science credit (2). Finally, teachers receiving science credit for agriculture courses were more likely to teach science courses than those not receiving science credit. However, many more teachers taught agriculture courses for science credit but no science courses (65) than taught both agricultural science and non-agricultural science courses (17).

Twenty-three teachers taught non-agricultural science courses in 1989-90, and 27 taught non-agricultural courses in 1990-91. For the 241 teachers, this is less than a two percent growth rate in teaching non-agricultural science courses. There were only eight teaching non-agricultural science courses and no agriculture courses receiving science credit in 1989-90, and only ten in 1990-91. This is less than a one percent growth rate.

Concern about agriculture teachers becoming science teachers is largely unsupported in this study. School administrators are more likely to use the science expertise of agriculture teachers to benefit agriculture programs, whether or not they are credentialed in science or receiving science credit. The image-enhancing and recruiting benefits of science credentialing and science credit far outweigh the risk of being absorbed by a science department.

Agriculture Courses Receiving Science Credit

Approximately 100 different titles were reported for 166 agriculture courses receiving science credit. Close to two-thirds of the courses probably had an agricultural production emphasis. As one might expect, courses in forestry and horticulture also received science credit. Some courses in agribusiness, agricultural mechanics and engineering, agricultural processing, and resource management received science credit. These patterns should expand visions for agriscience offerings in both life and physical science areas. From a program marketing standpoint, more descriptive and scientific course titles like "Animal and Plant Science" over traditional titles like "Ag I" are recommended.

Agriscience Laboratory Facilities

To really understand how agriculture programs have changed, one need only look at current laboratory facilities. Table 1 shows the scope and frequency of agriscience laboratory facilities. →

Table 1

Agriscience Laboratory Facilities

(data from 225 agriculture teachers)

Facility	Freq.	%
Ag Mechanics Laboratory	194	86
Land Laboratory	108	48
Greenhouse	107	48
Computer Laboratory	79	35
Tissue Culture Laboratory	16	7
Aquaculture Tanks	13	6
Meats Laboratory	11	5
Weather Station	9	4
Animal Housing/Laboratory	4	2
Floral Laboratory	2	1
Forestry Laboratory	2	1
Herbarium	1	<1
Hydroponics Laboratory	1	<1
Shade House	1	<1
Soil Moisture Probe Station	1	<1
Turf Plots	1	<1

Resource Sharing with Science Departments

Strong partnerships between agriculture and science departments hinge on sharing human, informational and physical resources. Resource sharing can extend the use of scarce resources while improving agricultural literacy, science literacy, and recruiting. The study found many agriculture teachers and science departments already sharing. While nearly the same number of science departments (73%) shared resources as agriculture teachers (67%) in 1989-90, agriculture teachers shared more resources overall. Even more impressive, more than 80% of agriculture teachers expected to borrow resources from science departments in future years. Agriculture program resources used by more than 20% of the science departments were 1) plant science equipment and supplies, 2) agricultural mechanics equipment and supplies, 3) agriculture advising students to take science courses, 4) audio-visual materials, and 5) the greenhouse. Science department resources used by more than 20% of the agriculture teachers were 1) microscopes, 2) informal program advice from science teachers, 3) glassware and plasticware, and 4) science audio-visual materials.

Although many agriculture teachers and science departments in the study shared resources, their sharing averaged only one or twice a year for each of five resource categories of 1) instructional services (e.g., team teaching), 2) equipment and supplies, 3) curriculum and instructional materials, 4) program support services (e.g., student or program advising), and 5) facilities. To build stronger partnerships between agriculture and science programs, partners should think about increasing their contacts.

Agriculture teachers who felt they needed resources from the science department for their instructional program found their new partnership with the science department rewarding, felt science belongs in their agriculture curriculum, felt the science department wants to work with them, and were more likely to share resources. How can agriculture teachers develop these positive feelings?

Only frequent professional contacts will help agriculture and science teachers learn what resources are available for improving their instructional programs. Frequent contacts will help develop trust — a prerequisite for sharing. Agriculture teachers should get involved with science programs and invite science faculty participation in the agriculture program. For example, a science teacher could serve on the agriculture advisory committee. An agriculture teacher could attend science department meetings.

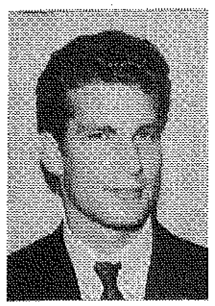
Agriculture has a scientific base, and science can be taught effectively with applied models and problems from agriculture. Agriculture and science faculty need to work together to integrate science into agriculture and agriculture into science. They can participate in inservice efforts, like the Agriscience Institute and Outreach Program, that build agriculture and science teacher partnerships while building competence in science and agriculture. These programs will help agriculture and science teachers discover the value and place science and agriculture have in their instructional programs. These programs can expand human, informational, and physical resources without sapping meager instructional budgets. They can build a friendly climate of cooperation, mutual respect, trust, and mutual reward.

Summary

Sound too good to be true? Interest in this study is based on the strong partnership we had with our high school science department when I was teaching agriculture. By having a dynamic agriscience and agribusiness instructional program with strong laboratory, FFA, and SAEP components we attracted many students. Our agriculture students were rewarded with life science credit for Introduction to Agriculture. Plant Science, and Animal Science courses; and physical science credit for Agricultural Physical Science (soils, agricultural chemicals, and integrated pest management). For each course science competencies were cross-referenced with agriculture competencies and presented to our district's science curriculum committee. Members of the committee knew us well and knew what we were doing in our instructional program. Finally, to teach science in our agriculture courses, we used many science department resources. When asked, we also got involved in the science department's instructional program. These strategies can work for others, too. ■

THEME ARTICLE

Improving Scientific Literacy Through an Agriscience Curriculum



BY CARY TREXLER and NONI MILLER

Mr. Trexler is coordinator of ABC in Science and Ms. Miller is Director of General Education, Sanilac Intermediate School District, Peck, MI.

By all accounts America has no more urgent priority than the reform of education in science ... (AAS, 1989, p. 3)

Scientific literacy is vital to a nation's cultural well being and to its economic competitiveness. Historically, workers with better skills meant greater production. While early farmers sowed seeds with draft horses producing only adequate harvests, progressive producers acquired new knowledge and skills leading to greater yields. Today, American workers' scientific skills are crucial for our economic survival.

In the late 1960s the International Assessment of Educational Progress (IAEP) began collecting worldwide data on students' scientific knowledge and skills. Over the last 30 years, IAEP notes that American students' proficiency has remained low. When compared among contemporaries from six developed countries, American teenagers score the lowest in scientific understanding. In 1988, 33% of Korean 13 year old students could apply intermediate scientific principles as compared to only 12% of the American students (USDE, MEAP, 1991).

Sanilac County

Sanilac County is a rural, agriculturally based community with 39,928 residents living within its 1,000 square mile border. It is the largest county in Michigan's lower peninsula; producing crops such as milk, cereal grains, and sugar beets. Education is delivered through seven local school districts that range in size from 516 to 2,210 students. These districts are assisted by the Sanilac Intermediate School District (SISD) — providing a link between federal and state agencies and educational programs and services.

The county mirrors both the State and Nation's student performance in scientific literacy. Few students enroll in agriculture and science courses, and from school to school, classes proceed as if scientific literacy can be attained by memorizing lists and facts. Students see science as textbook-driven, with little personal relevance, rather than as a web of interconnected ideas helping them to solve problems and bring understanding to their world.

Strategic Planning for Agricultural and Scientific Literacy

To strengthen both agricultural and scientific literacy, a committee of educators, community members, and industry leaders formed in the winter of 1991. They reviewed current agriculture and science educational research and authored a strategic plan recommending that teachers (1) connect science concepts to students' lives, (2) retool through the acquisition of new knowledge, and (3) adopt emerging teaching practices. Concomitantly, they believed agriculture must be understood by *all* students. Clearly, a need existed for innovative programming to infuse agricultural concepts into the science curriculum, inservice teachers, and create "hands-on" activities. Hence, the Agriculturally Based Curriculum in Science (ABC in Science) program was born with its overarching goal to improve scientific literacy among Sanilac County's 5,900+ K-8 students.

To attain this goal a supplemental funding source was needed. In the spring of 1991, the SISD submitted a proposal to the W. K. Kellogg Foundation and received funding in February 1992.

Design and Delivery of an Innovative K-8 Agriscience Program

Curriculum design and inservice education opportunities need to evolve together (NRC, 1988, p. 15).

ABC in Science's philosophy and program draws upon the National Academy of Sciences' 1988 report, *Understanding Agriculture: New Directions for Education*, the 1989 American Association for the Advancement of Science (AAAS) study *Science for All Americans: Project 2061*, and the *National Strategic Plan for Agricultural Education.*

Curriculum

Teaching science through agriculture would incorporate more agriculture into curricula, while more effectively teaching science (NRC, 1988, p. 11).

Three major sources were consulted when designing the fully integrated agriscience curriculum: Michigan's Department of Education *Michigan Essential Goals and Objectives for* →

ABC in Science Goals and Objectives

Goals	Objectives
• Increase awareness of the interrelationship of technology, science, agricultural and environmental science, & natural resources.	• Demonstrate knowledge of technology, science, agricultural and environmental science, and natural resources. • Demonstrate how technology interfaces with agricultural and environmental sciences. • Integrate agricultural and environmental sciences into daily life.
• Develop an articulated K-8th grade model for lifelong learning in agricultural and environmental science, & natural resources.	• Integrate objectives of Technology Education, State Science curriculum, and the AAAS Project 2061. • Develop and integrate audio-visual and software materials. • Develop customized workshops for K-8 classroom teachers.
• Empower classroom teachers and volunteers to deliver a county-wide agricultural and environmental science, and natural resources curriculum.	• Develop in-service workshops for classroom teachers and volunteers. • Create classroom kits and experimental activities. • Participate in The Summer Institute for Educator through MSU. • Publish a county-wide newsletter.
• Enhance the development of the "whole person" and foster positive leadership.	• Enhance student self esteem. • Enhance teachers self esteem. • Know the interconnection of science and daily life. • Increase problem solving skills. • Develop long term goal setting skills

Science Education (K-12) (1991), *Technology Education for Michigan* (1990), and the 1991 Agricultural Education advisory committee's *Report on Agricultural Education.* To foster ownership of the curriculum, agri-thematic science units were created by key classroom teachers. Units were then field tested, modified, professionally published, and disseminated. Hands-on activities from Michigan Farm Bureau's Ag in the Classroom program are also included. Via the agri-thematic science curriculum, kindergarten through fifth grade students develop an awareness of scientific concepts and principles, while their comprehensive exploration occurs in the middle school.

Inservice

Improvements in science education are not accomplished by merely adopting curriculum. Rather, to improve programs teachers must be empowered through new knowledge and skills. Well planned support by both school administration and local community is critical for the process of change. Through carefully designed workshops, supportive teacher networks are nurtured. To ensure success, a systematic, three-year inservice plan for K-8 teachers was developed. In addition to locally developed workshops, teachers will participate in Michigan State University's Summer Institute for Educators. The Institute explores creative ways for teaching K-12 students science, mathematics, economics, language arts, social studies, and other academic subjects. It is also designed to encourage teachers to examine concepts and materials drawn from the food and fiber industry, natural resources, economics, and life sciences.

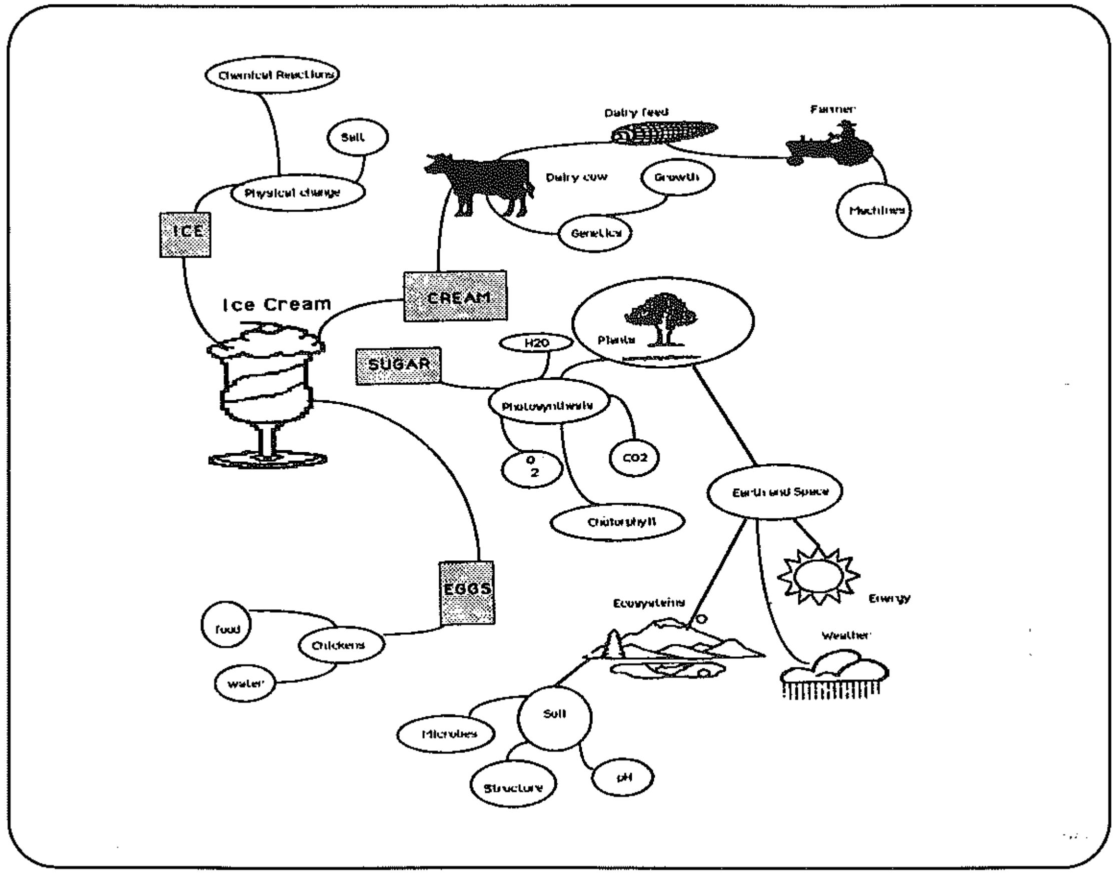
Hands-on Learning

ABC in Science helps teachers to carefully construct activities allowing students to make sense of what they learn and to create knowledge and understanding for themselves. Students are actively engaged in learning through agricultural themes. They "... dissect, measure, count, graph and compute, plant and cultivate, and systematically observe the social behaviors of humans and other animals" (AAAS, 1989, p. 147).

The program's architects, realizing both the value and time needed to create hands-on lessons, sought to provide students with experimental activities and more effectively utilize teacher planning time. To achieve this, they visited progressive scientific programs, observed practices, and then modified delivery systems for their own use.

Delivery System

The ABC in Science program's teacher and aide support the county's students and teachers. They travel to each school in a van identified by the brightly colored project logo. There, the project's staff assists classroom teachers and delivers kits containing agri-thematic science →



curriculum (workbooks) and manipulatives (hands-on supplies) needed for instruction. In contrast to many itinerant programs, students do not enter the van and walk out scientifically and agriculturally literate. Rather, the van's purposes are to a) transport support staff to classrooms, thus reducing the student-to-teacher ratio; b) serve as an economical and reliable means to move curriculum materials between schools, eliminating the necessity to fully equip each classroom; and c) serve as a motivational image for early elementary students, as well as an icon for agriscience education.

Newsletter

In an agriculturally based community, the citizenry must be scientifically literate to understand environmental and scientific issues. Economic competitiveness requires such knowledge. Published quarterly, the newsletter *ABC in Science* reaches out to community members, increasing agricultural and scientific literacy.

Conclusion

Clearly, in a world where rapidly changing scientific and technological advances drive production, America's cultural and economic future depends upon the scientific literacy of its people. For American agriculture's future economic competitiveness, we must lead the world in scientific research and apply these innovations to the food and fiber system. As developing countries increase their agricultural exports, they compete against the U.S. with cheaper, more plentiful workforces, less restrictive environmental regulations, and oftentimes unfair trade practices. For the strengthening of America's competitive edge, science education must connect to real world applications, thereby bringing relevance to learners.

Our country's future depends on scientific literacy, but current delivery of science education and its related technology falls short. Too few students are excited about learning science; science education must undergo a revolution.

Realizing the need to improve science education and the need for agricultural education to increase its audience, Sanilac Intermediate School District, its seven constituent school districts, and the W. K. Kellogg Foundation developed a partnership to integrate agriculture into the county's science curriculums — fostering both agricultural and scientific literacy. This curriculum integration does not require major reform; it relies upon innovation. Emphasis is placed upon conceptual understanding and real world applications. Agriculture is the theme webbing together curriculum contents and disciplines (Fogarty, 1991).

(Continued on Page 23)

Industry's Role in Developing a Science-Based Agriculture

BY RANDY BERNHARDT

Mr. Bernhardt is Southeastern Regional Director for the National FFA Foundation, Madison,. WI.

Our product is a highly motivated, industrious young American who is self-confident, self-reliant and self-respecting. Through FFA we are providing a cadre of bright and capable young people with good moral values and common sense. From them let our future leaders be chosen.

Tom Hennesey
1990 Chairman, National FFA Foundation
Chairman, TSC Stores
Nashville, Tennessee

Industry and individuals have long invested in agricultural education and FFA. These sponsors, nearly 3,000 in all, are really partners with agricultural education.

As agriculture has changed, so too have the interests and needs of agriculture students. As a partner with agricultural education, business and industry has provided and continues to provide input to assist in the direction of agricultural education.

Initiatives in Agricultural Science

New initiatives in agricultural science are being developed cooperatively between the National Council for Agricultural Education and the National FFA Foundation. These industry sponsored initiatives are mainly in the form of instructional materials packages for agriculture instructors. Programs are funded through the National FFA Foundation and are operated by The Council. Rather than add staff, The Council contracts with an agricultural education professional to direct the project.

These instructional materials initiatives are a result of interest generated by teachers, students, and/or industry. The manager of the project confers with industry executives and professionals in agricultural education. Additionally, industry and educational representatives review materials, contribute ideas, provide graphics, and suggest class demonstrations and student laboratory exercises appropriate to understanding the subject matter.

Agriscience Institute and Outreach Program for Science and Agriculture Teachers

The Agriscience Institute involves collaboration between teachers and scientists to develop instructional materials and student activities for science and agriculture teachers. The Institute provides instructors with an opportunity to enhance their skills and learn more about science, especially as it applies to agriculture.

The Agriscience Institute is a three-year program sponsored by the W. K. Kellogg Foundation. Agriculture and science teachers, preferably from the same high school, team up to develop "hands-on" instructional materials using WISCONSIN FAST PLANTS™ and "BOTTLE BIOLOGY" for use in their classrooms. Training will eventually expand to reach 4,800 to 6,000 agriculture and science instructors nationwide. This instructional program is endorsed by the National Vocational Agriculture Teachers Association (NVATA), National Association of Biology Teachers, and business/industry.

Food Science and Safety Programs

The media (newspapers, magazines, television, etc.) are constantly referring to "problems" in our food supply. Some of these reports are factual or unbiased. Unfortunately, a number of such reports indicate a lack of understanding about the United States food supply, food safety, and health issues. The general public has a lack of understanding of agriculture and the food industry.

The Food Science and Safety Instructional Materials program is designed to educate young people about the food supply and food safety. The program will provide teachers with materials on food safety. The project will include a number of "hands-on" experiments and activities for students to conduct.

Not only agriculture students will benefit from this program. Students in home economics will also receive training in all aspects of food safety. By targeting both agriculture and home economics instructors, not only are future employees of food production and processing reached, but also future consumers of U.S. food products.

As Gary Costly, President, U.S. Food Products Division of Kellogg Company, Battle Creek, Michigan, states, "I believe that programs such as these are a worthwhile investment. FFA has developed a hard-hitting, action-oriented learning program in Food Safety." →

Materials for the Food Science and Safety program will be printed and distributed for teacher training nationwide beginning in Fall 1993.

Agricultural Issues Curriculum and Activity

Many students don't understand the various issues facing the agricultural industry, especially in the United States. Many times students are not able to personally discuss or defend their position on issues pertaining to the environment, animal welfare, technology and its products (ie, genetic engineering, BST, etc.), and political issues (ie, government support/payments, 1990 Farm Bill, etc.).

The purpose of the curriculum and activity is to increase awareness of agricultural issues among the agricultural and non-agricultural public. This will be accomplished in two ways: development of curriculum on agricultural issues for high school agriculture programs, and development of an Agricultural Issues Forum activity. The curriculum and instructional materials will include lesson plans and student activities (ie, forum and discussion activities). Instructional materials will emphasize the analysis of agricultural issues through agricultural literacy and communication skills.

The Agricultural Issues Forum Activity will be an FFA activity designed to promote further discussion of agricultural issues. Students will be encouraged to participate in and earn recognition/awards for (1) number of presentations made or discussions on agricultural issues given to local/non-agricultural groups, and (2) number of students involved in the program.

A team composed of industry and educational representatives outlined specific units of instruction, will review materials, and will make recommendations for the content of the Curriculum and Activity.

Students from Kansas City's East Environmental Sciences and Agribusiness High School visit with food scientists at Farmland Industries' test kitchens.

Groundwater Resources/Protection Instructional Materials

"Water is a critical resource for agriculture; our farms and industries use immense quantities and its protection may be one of the most important environmental issues of this decade. Approximately 50% of all Americans and 95% of rural residents depend upon groundwater as their primary source of drinking water. This makes groundwater an extremely valuable resource which is often neglected and taken for granted."

Jeff Moss
Groundwater Resources/Protection
Project Manager
University of Illinois
Urbana, Illinois

The Groundwater instructional materials were developed and first distributed through teacher training programs in 1990. Training workshops are scheduled for completion in 1994. The demand for these instructional materials has been phenomenal. Jeff Moss, project director, is planning for a third printing of the materials. The program is funded by the National FFA Foundation and is operated by the NVATA. It is funded by a diverse coalition of business and industry sponsors.

The groundwater instructional materials have been developed for use with high school students. The complete learning unit on groundwater protection includes teaching materials, overhead transparencies, teaching strategies, teacher demonstrations, and student laboratory exercises.

Maximizing Economic Yields

The development of instructional materials on the subject of Maximizing Economic Yields is a national initiative. The materials will provide agriculture instructors with lesson plans to acquaint students with the concept and implementation of maximum economic yield, its impact on profitable agriculture, sustainable/alternative agriculture, and environmental concerns.

The development of these instructional materials is a result of NVATA workshops sponsored by IMC Fertilizer, Inc. in 1989 and 1990. Instructors participating in the workshop wanted more teacher-friendly materials on this subject. Thus, the National FFA Foundation secured industry partners interested in developing Maximizing Economic Yield teaching materials. In 1992, 1993, and 1994, Maximizing Economic Yield instructional materials will be distributed to agriculture departments through teacher training sessions.

No-Till Agriculture Instructional Materials

The objective of the No-Till Agriculture Instructional Materials is to provide instructors with a concise, step-by-step reference to guide

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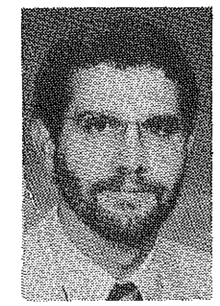
CLASSROOM TECHNIQUES

Making the Most of the Time in Your Classroom



BY GARY S. STRAQUADINE

Dr. Straquadine is assistant professor and assistant head of the Department of Agricultural Systems and Technology at Utah State University.

The school bell rings signaling the beginning of another period in your classroom. The majority of your students have entered the classroom and probably have taken their seats for another session under your instructional command. Some schools have designed instruction to occur in distinct 50 minute periods over the typical 18-week semester system. Others offer instruction over 60, 70, or even 75 minute periods in a trimester basis. Still others will have teachers working with students in specific courses on alternate days, referred to as A/B day scheduling. Regardless of the scheduling plan or length of the term, an important issue concerning the quality of your instructional program relates to the amount of time your students are on task.

The concept of time-on-task in education is not new. In 1974, Benjamin Bloom defined this concept as the time students are actively engaged in learning activities. The National Commission on Excellence in Education, in their preeminent report *A Nation at Risk: The Imperative for Educational Reform,* questioned the use of time in the classroom and challenged all educators to optimize the use of time for the enhancement of instruction.

Several alternatives to increasing the time for learning have been suggested. For example, to increase the amount of time students are actively engaged in learning, why not lengthen the school day or the school year? Many school systems struggling with limited resources cannot afford this solution. Perhaps it would be best to increase the number of academic credits for graduation. Yet, this could act upon a currently staggering national dropout rate of 28%, while resulting in a less than adequately trained workforce. A final alternative advocates the increased use of homework assignments to extend learning to periods outside of the classroom. While a simple suggestion for improvement to cognitive levels of instruction in academic courses, how can the use of homework help us in agricultural education when specialized equipment, facilities, and materials make the teaching and learning process an imitation of current agricultural science, technology, and management practices?

The most suitable alternative to increasing the amount of time students are actively engaged in learning is to maximize available class time. Keep your students on task while under your mentorship.

How are students currently using their time in your classroom? Research by Halasz and Behm indicated that vocational students in secondary schools were on task 71% of the time. The balance of the time, 29%, students were not on task. Of the majority of time students were found on task, almost 53% of the time was spent practicing specific skills. Another 30% of the time-on-task was in exploration of theory or content. Of the time spent off task, the majority of students were waiting for equipment, materials, or teacher assistance.

How you use the time for instruction in your classroom will reflect your understanding of the role of time-on-task in your agriculture program and your personal teaching style. Through my years in agricultural education as a teacher, a state-level supervisor of teachers, and now a teacher educator, I have seen teachers that get down to business at the sound of the bell. Then again, there were teachers who weren't even sure they heard a bell! My observations have allowed me to identify several techniques you may find useful in maximizing your student's time-on-task.

1. *Demonstrate to your students that time is an important resource.* Students need to see and feel the value of time in working toward the completion of the instructional unit. Wasted time cannot be recaptured for future use. Plan and organize class activities in advance and stick to your schedule. Remember, you also serve as a role model for the world of work. Your time must emulate your expectations for your students.
2. *Clearly define student and class goals.* Students need to understand their responsibilities in succeeding in your class. Very early in the term of instruction you must establish course goals. By allowing your students to assist in the development of these goals they will become more aware of the use of time in the teaching and learning process.
3. *Use a wider range of teaching methods.* To stimulate students and therefore keep them on task, vary your teaching approach. With proper planning, theory and content can come alive with the use of a resource person, case study, or experimentation. Additionally,

(Continued on Page 23)

FEATURE COLUMN

AQUACULTURE
What the Fish Have Taught Me

BY MICHAEL WALSH

Mr. Walsh is an agriculture teacher at Rochelle High School, Rochelle, IL.

It has now been just over two years since my first introduction to the field of aquaculture. It all started in a teacher inservice workshop. Our agriculture department and FFA chapter have been solely responsible for the financial, managerial, design, and day-to-day running of the Tilapia operation. We are currently preparing to harvest the first of our 700 fish — a day that at times I thought would never get here. Over the past two years we have seen many ups and downs, successes and failures, but there was always a positive element to even the biggest catastrophes. Since our project began I have tried to reinforce two attitudes towards the project. First, we have adopted a portion of the FFA motto "Learning to do, Doing to learn..." It was terribly important that the students and myself gain the technical and the not-so-technical information needed to successfully raise a group of fish from the fingerling stage through to harvest. Most of what we tried to implement was new to the students and to myself. It was like the blind leading the blind at times. The good thing was that we were learning from the experience — learning why it worked or why it didn't and how to modify the plans to make it work. A lot of what we tried to implement just plain did not work. Things would need to be done over and over again, each time with some degree of modification. Secondly, we learned from our mistakes. Whoever said that one learns from one's mistakes was right. It's nice to have success, but when there are no failures to bring you back down to earth, the success is somewhat shallow. Fortunately, we have experienced our share of failures.

Don't Believe Everything You Read

As we were starting our aquaculture venture, the students and I were reading everything we could get our hands on that was related to aquaculture, and more specifically, Tilapia. In northern Illinois there isn't a great deal of press or even publications on Tilapia. Even the local university library didn't have much on the subject. And what they did have was very old, published in the 1950s and 1960s, or it was written in a foreign language, or it was describing Tilapia culture halfway around the world. We were looking for applications that could be applied to indoor intensive aquaculture in Illinois, where winter temperatures are known to drop well below zero. After months and months of research I still have not really found the references I need. The maintenance staff at our high school keeps telling us to write our own book on Tilapia culture, now that we have made a full production cycle. At first, everything that was written said that one could expect to raise Tilapia from the one and one-half inch fingerling stage to the one and one-half pound harvest weight in six months. NOT. Later we read that a more realistic time frame was nine months. NOT. Of course, I can see the possibility of having the most OPTIMUM conditions of water temperature, oxygen, nitrites, feeding amounts and frequency, water quality, and every other variable, and raising the fish in a time frame of six to nine months. In our own situation it has taken a full 10 months for us to harvest 100 of the 700 fish in the tank. The fish are at all different sizes and weights. The next group will probably not be harvested until sometime during the twelfth month. After a full year of production time and money invested in these fish, we still will not have had a complete harvest; there will still be fish left from the originally purchased start-up group. But we are learning.

Have An Emergency Backup Generator

Since we started, everyone was telling us we had better have some kind of backup generator in case there is a power failure. Although I was never opposed to the idea, I felt that there were things that should be and were higher on the priority list. Therefore, no backup plan was devised at first. It was a great idea to have one, considering the frequency of power outages in this area, especially over the winter months. The cost of a gas-powered generator was more than we were initially willing to spend. We approached it from the standpoint that we would wait and see. Maybe there was a more cost effective way to handle the emergency situations. Once our operation was established we invested in a pure oxygen injection system. The main concern during a power failure was the lack of oxygen, not necessarily the fact that you need electricity. The fact that during a power outage fans, most pumps, and lights would not be operational was not life threatening. However, even during a short outage, supplemental →

oxygen needs to be added. Our emergency plan was to have a tank of pure oxygen nearby connected to an air diffusion tube that was laid out on the bottom of our tank. During a power outage the oxygen tank would be manually turned on and regulated by the flow meter. This would provide the fish with adequate levels of oxygen for even long-term outages. The only other need would be to have flowing water over the biofilter at least once every 20 minutes. We met the needs of the oxygen but relied on a manual system of pouring water over the biofilter to keep it alive. Fortunately, our longest power failure in the past two years has been only 15 minutes, and that occurred on a day when school was in session and we were immediately aware of the problem. We have used our emergency oxygen system, and it works well. However, we have not had to manually pour water over the biofilter; this is an area that needs improvement. But, we are learning.

The aquaculture program has made me a better teacher. It has made me an agriscience teacher.

Relearning the Sciences

The aquaculture program has made a better teacher. It has made me an agriscience teacher. I am finding myself relearning even the most basic of science concepts. My agriculture classroom is filling up with beakers, flasks, and test tubes for water quality testing. A couple of microscopes can even be found. With the microscope we are looking at bacteria in the water and identifying the various aquatic plants and animals that are found in our tank, as well as the pond and river nearby. I am enjoying this new science-charged curriculum, and the students are finding it challenging as well. Most of the science concepts and techniques that are being taught are being relearned a few days prior to my teaching them. And the students are doing some of the teaching, too. When we get to a certain area, the students are teaching me or bringing me up to date on what direction they think the experiment should take. Math skills are also being tested. Whether we are figuring tank size or setting up a feeding rate and frequency formulas, math skills are being sharpened.

After teaching one semester of aquaculture I soon realized that one could go about 100 different directions with it, and there is enough information to teach six different aquaculture classes.

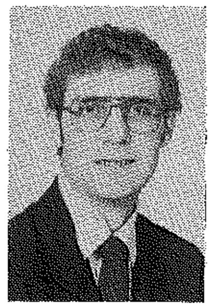
The Class

For the first time this past school year, the agriculture department had offered a one-semester course in aquaculture. Enrollment for the class was closed when enrollment reached 20 students — the maximum for a lab class. This same class is being offered next school year, and it has been expanded to two semesters — a full year of aquaculture. The early enrollment figures show solid numbers. After teaching one semester of aquaculture I soon realized that one could go about 100 different directions with it, and there is enough information to teach six different aquaculture classes. During this past year's class, the students ranged from sophomores to seniors, and a few low achieving students to students that were academically at the top of their class. For the most part students were grouped into eight sets of lab partners. Lab groups were two to three students each, and students were assigned to reflect a wide range of talents and abilities. The major emphasis of this first-ever class was to monitor and correct water quality factors, as necessary. Each Friday of the week was spent in the aquaculture lab doing hands-on work such as cleaning, general maintenance, and installing or changing various components of the total system. At least one other day per week was spent in the lab groups performing basic water testing procedures and experiments. Students were assigned a research paper on the aquaculture topic of their choice in hopes of bringing in additional information to the class that was not readily available from the teacher. Overall, the class was effective in that it provided students a closer look at what aquaculture was all about and possible career choices in a nontraditional field of agriculture.

A Look Back

As we look back over the past couple of years, we see that our local aquaculture program and facility has made quite an evolution from the first days when we started. We thought we would have a decent facility, and we were hoping for some degree of success. What we have is a tremendous facility that is creating interest from around the state and even in neighboring states. Many groups and individuals have written or called to inquire about touring the facilities. The aquaculture lab brought a lot of positive public relations to the school district, agriculture department, and to myself personally. As far as success, it has been a tremendous success. We have been able to harvest our first group of fish, the aquaculture lab has brought a new clientele into the agriculture department, and the students are actually learning and gaining from their experiences. And, we are still learning.

Using Technology to Teach Agriculture



BY VAN SHELHAMER
and BOB MCBLAIR

Dr. Shelhamer is associate professor of agricultural education at Montana State University and Mr. McBlair is an agriculture teacher at Chinook, MT.

Technological advances in every aspect of our lives demand education in the use of new technologies. The space age has created an entirely new need for food plants to be grown in non-soil environments or different atmospheres. Global Positioning Systems will allow producers to farm the soil rather than fields. Thus comes the new educational challenge — using technology to teach agriculture, science, research, and environmental concerns.

Can chemistry, biology, electronics, computers, communications and hands-on activities all be included in one educational activity? Probably not, unless you are using the latest technology in your instructional approach.

Several Montana agriculture programs are using a technology developed to teach chemistry in the laboratory at Montana State University. The technology enhances the instructional approach when teaching certain science principles. Integration of academic subjects is easily achieved and cooperation between the chemistry teacher and the agriculture teacher is enhanced.

The agriculture teacher and students at Chinook, Montana are demonstrating how technology can be used to teach science, research, and environmental concerns. By use of a microcomputer Sci-Labworks Interface students can design research activities, test their hypotheses, and see the results in a matter of minutes. For example, students can measure the effects of fertilizer on soil acidity in one lab period. The effects of soil color on soil temperature can be monitored over a period of time with readings taken at an interval rate of seconds to hours. The computer will graph and print the results for interpretation. Thus, the effects of various production practices on soil temperature can be observed in the laboratory.

The Sci-Labworks Interface is an accurate and specific means of collecting data on pH, temperature, electron flow, and light sensitivity. The software developed with the Interface allows the computer to display the data on its own spreadsheet, chart, or direct readings on the screen. The experiments completed with the Interface must be custom programmed before activities can successfully be completed. Programming! Yes, the software uses a pull down menu, which makes programming as simple as using a menu driven spreadsheet program. Programming puts the student in total control of what is to be done. It gives students the opportunity to manipulate and experiment with ideas and objects, as the software program can be modified is less than a minute. This flexibility leads to experimentation, originality and creativity. Thus, the teacher acts as a resource and fellow learner, rather than a fountain of knowledge. Consequently, students become self-directed learners, and the learning process is interesting.

Temperatures can be measured at intervals of milliseconds, seconds, or minutes. pH can be measured in hundredths of a whole number. Electric conductivity can be measured in millivolts, volts, etc. Timers can be set to activate switches or take readings from various sensors within a variety of time frames.

Research activities that students can conduct include measuring the pH of rumen content of a steer on a hay ration or pasture as compared to a steer on a heavier grain ration, measuring temperature drop of soil or water as wind blows across the surface, measuring groundwater contaminates, turbidity of water, pH of new and used antifreeze, and use of the Interface to activate electrical and hydraulic systems.

Learning is discovery based, fact finding, exciting, and it becomes meaningful to the students. Students using the system have become highly motivated to learn about scientific principles that can be discovered by using the Interface. Students are exploring more concepts and asking more questions because of the interactive nature of the system. Students are in control of their learning. Instant feedback in graph form helps students recognize relationships that would otherwise not be recognized. Also, students do not have to spend time number crunching. Thus, more time is available for studying the results. Instant feedback eliminates the need to wait for significant changes to occur before changes can be noticed. For example, blowing on the electronic thermometer immediately shows the temperature change. There is no waiting like would be experienced when conducting an experiment with a regular thermometer, and the results can be graphed on the screen as the temperature changes.

Agriculture students at Chinook High School are learning and testing science principles that apply to agriculture. They are learning research methods and techniques that will open the door to new technologies and understanding. Communication between man and machine is learned. The role of electronics in agriculture is better understood. In addition, students who later enroll at Montana State University or other universities →

Using Technology ...

(Continued from Page 22)

using Sci-Labworks will discover that chemistry laboratory classes are much easier and more interesting. Academic integration occurs and the chemistry teacher, student, and agriculture teacher form a working partnership — a partnership that leads to new discoveries and understanding.

Making the Most ...

(Continued from Page 19)

encourage your students to work independently when stymied in a problem set or, with your approval, cooperatively with other students.

4. *Assign meaningful tasks.* Nothing will take a student off task quicker than busywork or the monotonous. When students can see value and purpose in their learning activities, they will stay on task longer. Assess your current use of assignments, practice exercises, or lab work and progress the busyness to meaningful activity.
5. *Decrease opportunities for interruptions from outside your classroom or lab.* An interruption for unscheduled announcements, visitors (or drifters), and students leaving early for an assortment of reasons can take your class off task very quickly. Establish classroom procedures for handling these interruptions to keep your students on task. Work with your building administrators to review the use of these procedures and to ask for their compliance.

Time-on-task is an important issue for all teachers. To minimize the quality of instruction in your agriculture classroom, you must maximize the amount of time your students are actively engaged in learning. To borrow from an Eastern proverb, "Finding time is difficult. If you want time, make it!".

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Industry's Role ...

(Continued from Page 18)

the transition from farming with tillage to farming without. These instructional materials would identify the do's and don'ts of introducing and maintaining a no-till system.

Interest in the no-till concept accelerated amongst agriculture teachers in the Midwest in large part due to NVATA workshops on this tillage concept sponsored by BASF Corporation. An educational package will be developed that will include a No-Till User's Manual and related videotapes, in addition to the instructional materials and student learning activities. Selected states in the Midwest will be offered free training in 1993 and 1994. These materials will be made available upon a request basis in all other states.

Other instructional materials that are in the proposal or developmental stage at the national level include Environmental Education, Animal Welfare Education, Integrated Pest Management/ Organic Foods, Sustainable Agriculture Curriculum, and Biotechnology. These newest of initiatives have surfaced because educational professionals and industry professionals have expressed an interest in these issues.

Industry has proven, over the years, to be a valuable partner as agriculture teachers upgrade to provide more science-based education. Certainly their financial investment in these national instructional materials programs is vital. As important is the knowledge and expertise that industry can lend to such projects as they progress from the developmental stages to final teacher training and distribution of the materials. Industry's partnership is helping agriculture instructors teach the science of agriculture. ■

Improving Scientific ...

(Continued from Page 16)

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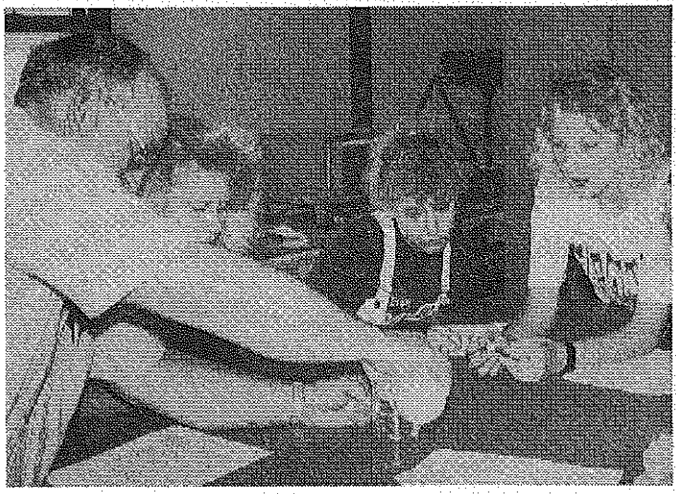
STORIES IN PICTURES

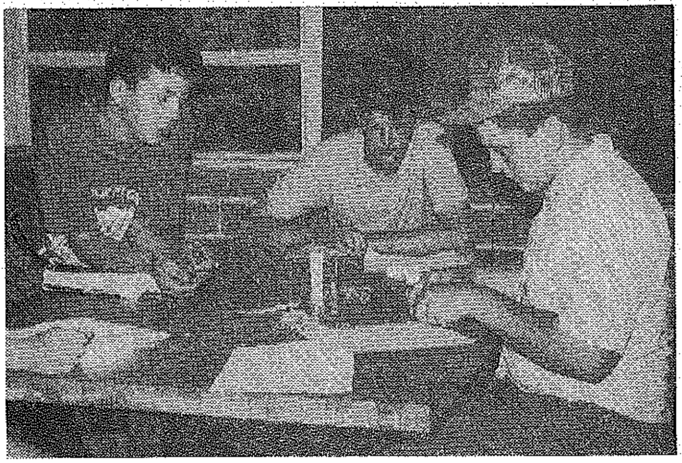
(Photos courtesy of Jeff Moss, University of Illinois)



Agriculture teacher John Rentfrow at Shelbyville High School demonstrates proper procedures for conducting a chromatography experiment from the Biological Science Applications In Agriculture (BSAA) Curriculum used in Illinois.

Teachers attending an Outreach workshop of the Agriscience Institute held in LaSalle-Peru, Illinois, are getting "hands-on" practice in making bottle constructions for conducting experiments.

Enhancing collaboration between science and agriculture teachers is a major goal of the Agriscience Institute. Richard Seidel (agriculture teacher) and Julie Healy (science teacher) from Altamont High School are planting Fast Plants seed at an Institute Outreach Workshop in Vandalia, Illinois.



Student experimentation in cooperative learning groups is an excellent method for teaching agriscience. These students at Shelbyville High School are investigating the types of pigments found in plant leaves.