DEVELOPMENT AND EVALUATION OF AN INSTRUCTIONAL UNIT IN INTEGRATED PEST MANAGEMENT:
EVALUATION OF STUDENT KNOWLEDGE AND ATTITUDES AS A RESULT OF INSTRUCTION

A Thesis in
Agricultural Education

by
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Submitted in Partial Fulfillment of the Requirements for the Degree of

Doctor of Philosophy

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ABSTRACT

The purpose of this study was to develop and evaluate an IPM instructional unit for secondary science and agricultural science classes. The target audience was secondary school science and agricultural science students in grades 10 through 12 from high schools in Pennsylvania. In an effort to control instructor bias, it was the desire of the researcher that the same instructor present the material to both science and agricultural science students. Seven instructors, in seven different school districts, met the criterion. With the permission of their administration, five instructors agreed to be included as cooperators in the research.

The evaluation component of the research was based on internal and external summative evaluations. The internal summative evaluations measured students’ changes in IPM knowledge and attitudes as a result of receiving instruction. The instructors administered the pretest knowledge and attitude instruments prior to the start of the IPM unit. Upon completion of the nine-lesson IPM unit, the instructor administered the posttest knowledge and attitude instruments. The instructors forwarded the data from participating students to the researcher for data analysis. External summative evaluations were conducted to determine strengths and weaknesses of the unit from the viewpoint of educators. Participating instructors and outside content and curriculum specialists were asked to complete a written evaluation of the unit.

Statistical analyses of the pretest and posttest data indicate a significant increase in knowledge for both the secondary science and agricultural science students. Analysis of the data collected regarding student’s attitudes relative to
IPM concepts also indicates significant changes in attitudes. All of the summative evaluations from participating instructors and external evaluators were positive and indicated the evaluators felt the instructional unit would be utilized as part of a curriculum and that students would find it interesting to study.

The inclusion of an IPM educational unit that is balanced in its perceptions into the already existing secondary science and agricultural science curricula can serve several purposes. In regard to youth education, The Pennsylvania Department of Education is currently in the process of developing Environment and Ecology Academic Standards. IPM learning objectives are included in these new standards. The unit evaluated in this study will help fill the need to provide instruction so that students will be prepared to meet the state standards and score well on PSSA exams.

However, more importantly, mastery of the concepts in the IPM unit of instructions will help to prepare students to be more informed consumers, more environmentally aware of alternatives for pest control, and safer applicators if and when the need to use pesticides arises. Appropriate education of today’s consumers will help them make informed decisions regarding pest control, alternatives to pesticide use, safe use of pesticides when necessary and pesticide residues on foods.
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walked into a college class I have been trying to live up to what I thought were your expectations. As I complete this final step in my education, I have finally learned that the only expectation you had was that I do my best and that I be happy. To my “wicked step-children,” thank-you for humoring me through the times when I became the “phantom” or “wicked” step-mother. I could not love you more if I hatched you myself as opposed to finding you in Walmart. Rick, in all of your roles, as my husband, my best friend and “cattle prod,” you have been tireless. The turning point in all of this was the moment that you dried my tears and reminded me, “if it were easy, everyone would have a Ph.D.” For all my education, I am convinced you already knew more than I have ever learned.
Dedication

In honor and memory of Dr. Donald E. Evans
My major professor in all of life. A champion for me during this work and always for the betterment of the agricultural industry. I miss your guidance, boundless energy and dedication. However, I know that through the lessons that you have taught me, and many others, you will be with us always.
In 1962 Rachael Carson’s book, *Silent Spring*, brought the issue of pesticide use to the forefront of consumer and environmentalist concerns. By year’s end, Audubon and National Parks magazines had published excerpts from the book which eventually became a best seller. However, it must be noted that Carson’s book created quite a bit of controversy. According to Environmentalist Peter Matthiessen, “A huge counterattack was organized and led by the whole chemical industry--duly supported by the Agricultural Department and the more cautious in the media.” He also noted that, “In their ugly campaign to reduce a brave scientist’s protest to a matter of public relations, the chemical interests had only increased public awareness” (Time, March 1999, p. 189). In 1989, the use of Alar® on apples once again raised consumer awareness in regard to pesticide use. State and national agencies regulated Alar®, a growth regulator that helped to synchronize when apples drop from the tree, with the same criteria used for pesticide registration. “The use of Alar® in apple production was banned because of public scrutiny” (Marshall & Henning, 1991, p. 9). In the case of Alar®, concern focused on the use of chemicals on food crops, and the residue that remained on the food. Ironically, results of the federal government’s program to monitor pesticide residues on the foods we eat, “The Total Diet Study,” show this concern to be overstated. Approximately 66.5% percent of foods sampled show no detectable pesticide residue. Nearly 32% percent of the sample showed detectable residues within legal tolerance levels. Less than two percent of the
samples had violative residues (levels above established government safety
tolerances) (FDA, 1999). The majority of these violations were due to the use of
pesticides in a manner not currently registered by the EPA. Even in light of
this information, consumer concern persists. Almost three quarters of the
consumers interviewed between 1988 and 1994 by the Food Marketing Institute
felt that residues were a serious hazard (Trends, 1994). Furthermore, in other
surveys consumers have expressed a low confidence in the governments’
ability to adequately regulate pesticide use (Warren et al., 1990).

A more relevant, and documented, issue is that of pesticide use and
misuse in the home environment. In 1992, the Environmental Protection
Agency (EPA) released the findings of the National Home and Garden
Pesticide Use Survey that provided data regarding non-agricultural use of
pesticides in and around urban and rural homes (EPA, 1992). The survey
included on-site visits to over 2000 households in 29 states. The findings of
this survey show widespread homeowner use of pesticides. Approximately 76
percent of the households treated their homes themselves for insects and
related pests. An additional 20 percent indicated that a professional
commercial applicator was hired to treat for household pests. An estimated 85
percent of all households surveyed had at least one pesticide in storage around
the home; most families had between one and five pesticide products stored.
More than a quarter of the households had more than six products in storage.
In households that did not have children under the age of five living in the
home, about 75 percent had at least one pesticide stored, in an unsecured
manner, less than four feet off the ground. Forty-seven percent of those
households where a child less than five years of age was in residence also had
at least one pesticide stored, in an unsecured manner, less than four feet off the ground.

Recent misuse of methyl parathion for the treatment of residences and businesses in urban areas is the most dramatic example of the need for education. Methyl parathion is an insecticide used effectively by agricultural producers for years. If applied according to label directions it can be used safely. It is not labeled for home use. However, hundreds of unsuspecting consumers, uneducated in regard to safe use of pesticides and alternative methods of pest control, allowed their households, and businesses, to be treated with this agricultural chemical. In Ohio, the individual responsible pleaded guilty to violating state laws by spraying methyl parathion in more than 200 homes in two Ohio counties in the 1990's. The cleanup from these incidents cost over $20 million (Agency for Toxic Substances Disease Registry, ATSDR, 1997). In April 1995, a similar incident was discovered in Detroit, Michigan. Four residences, including a homeless mission, required "decontamination and restoration," costing approximately $1 million (ATSDR, 1997). Cleanup costs totaled over $50 million in Mississippi, where over a two-year period more than 1,500 homes and businesses were illegally treated with methyl parathion. As part of their research, EPA staff compiled records of 22 accidental deaths since the mid-1960s caused by illegal home use of methyl parathion or ethyl parathion. Some of the victims were children who died after drinking pesticides from unmarked containers (Natural Life, 1997; Pesticide Action Network, 1997). Veterinarians also reported deaths of household pets as a result of methyl parathion exposure (EPA, 1997).
Media stories regarding misuse of pesticides in urban areas and homes, and concerns by public interest groups relative to pesticide use in schools, are just two issues that have brought attention to the use of Integrated Pest Management (IPM) in areas other than traditional agriculture. IPM, the use of multiple alternatives for pest control, is not a new concept. For decades, progressive agriculturists have been balancing chemical and non-chemical methods of pest control to reach the most cost-effective, practical solutions to pest problems. An IPM program is built around the following components:

1. Monitoring the pest population and other relevant factors
2. Identifying the pest accurately to ensure selection of correct control methods.
3. Determining injury and action levels that trigger treatments.
4. Timing treatments to the best advantage for control of pest problems.
5. Selecting from a variety of treatment options, both non-chemical and non-chemical.
6. Evaluating the effectiveness of treatments to fine-tune future actions
7. Educating all people involved with control of the pest problem.

In regard to pest management and pesticide education, it is no longer enough to educate only the pesticide applicator whose livelihood depends in part on the safe and responsible use of pesticides. It is also important to educate the consumer for two basic reasons. Primarily, this education will help homeowners to understand the principles related to alternatives to pesticide use around the home, as well as safe use and handling of pesticides when their use is necessary. Just as important, education of this type will allow consumers to become more informed and give them the ability to make
decisions based on sound knowledge, for, “As educators our primary responsibility is to transfer knowledge” (Marshall & Herring, 1991, p. 10).

A desire to develop informed consumers can also be linked to the national concern about public understanding of science or science literacy (Shortland, 1988). Shortland proposes that a scientifically literate individual is educated to cope with science, and is given a respect for both the expertise and human fallibilities of scientists. Therefore, that individual is better able to make informed judgments about the personal, political and social relevance of scientific information and its impact on society.

Need for the Study

Appropriate education of today’s youth will help them make informed decisions regarding pest control, alternatives to pesticide use, safe use of pesticides when necessary and pesticide residues on foods. This type of education is imperative, not only to protect human health and safety, but also to preserve the environment. Researchers have noted the importance of educating the non-agricultural public, whose opinions influence the market place and new federal and state regulations. In addition researchers (Travis & Rajotte, 1995) urge the implementation of educational programs that help consumers understand how Integrated Pest Management (IPM) can help lead to safer food and a cleaner environment. The following examples illustrate the potential for incorporating IPM into existing school curriculum.

During the 1992-1993 school year the Pennsylvania Envirothon program included pesticides as the “current issue station.” The Envirothon program began in Pennsylvania as an initiative of several conservation districts. The
Envirothon developed over the years into an environmental education competition that focuses on aquatics, wildlife, soils, and forestry. In addition, each year the program selects a particular topic that is currently a prominent environmental issue. This is referred to as the “current issue station.” When the state Envirothon concluded in June 1993, an estimated 10,000 students were introduced to the concepts of pesticide safety presented in the instructional unit. Feedback from the Envirothon staff indicated that evaluations completed by students and instructors were positive and even included the suggestion that pesticides should become an annual part of the Envirothon competition. One suggestion for improvement of the materials was to include information on alternatives to pesticides in addition to pesticide safety. These comments indicated the need to develop an IPM instructional unit.

When the state of Pennsylvania was selected to host the tenth annual National Envirothon in 1997, Modern Pest Management was selected as the “current issue” station. During the fall of 1996 and the spring of 1997, the original pesticide safety instructional unit used in the 1992 Envirothon was revised, reviewed by a panel of experts, and disseminated to over 400 schools in 57 counties in Pennsylvania. Exams were developed for local and state competitions. The revised IPM instructional unit and support materials were then sent to 33 states and three Canadian provinces whose students were participants in the National Envirothon. Although the IPM instructional unit and resource materials were widely accepted by the instructors involved with the Envirothon program, some improvements were suggested, and changes were made to the final instructional unit (Appendix A).
In addition, a number of environmental, social and political forces are converging to make this the “right time” for use of an IPM curriculum to foster scientific literacy and provide a mechanism for changing attitudes and behaviors regarding pesticide use and pest management (Garling, 1999). Some of these forces include:

1. The Food Quality Protection Act, which may mandate reduced use of certain pesticides in non-agricultural situations, such as homeowner use (Hock, Hoffman & Gripp, 1999).

2. Increased emphasis on IPM education for the general public to prevent misuse of pesticides.

3. Increased environmental awareness on the part of public interest groups, parents, industry, and government agencies which is pressing the issue of pesticide use in and around schools.

Several recent developments in Pennsylvania illustrate the need for this study. In his final presidential address to the Pennsylvania Association of Agricultural Educators (Metzler, 1999) President Lehman Metzler noted:

One area where I sense a vacuum currently is in the creation of new curriculum materials or even the sorting through of that which is available and making it available to teachers. Curriculum development will serve, not only to get our new teachers off to a good start; it will also facilitate the ability of current teachers to update what is taught in the classroom.” (Metzler, 1999, in an address at PAAE annual convention)

More importantly, The Pennsylvania Department of Education is currently in the process of developing Environment and Ecology Academic Standards. IPM learning objectives are included in these new standards (Appendix B). The inclusion of these objectives were based in part on survey results (Minner, 1998) which indicate that, of all identified areas of study,
agricultural diversity and IPM were taught with the least frequency (Appendix B). It must be noted that the new standards are not mandatory and local districts have the freedom to set curriculum standards (PDE, 1999a). However, Pennsylvania's State Standardized Assessments (PSSA) exams will be designed around the new standards. As a result, if students are to perform well on the PSSA exam, instruction regarding concepts outlined in the new standards must be provided for students.

In October of 1998, the Pennsylvania Department of Education and the Department of Agriculture, along with The Pennsylvania State University's College of Agricultural Sciences and College of Education, signed a Memorandum of Understanding (MOU) (Appendix C) to collaborate in bringing IPM practices and K-12 education into schools in Pennsylvania. Dr. Robert D. Steele, Dean of The Pennsylvania State University's College of Agricultural Sciences, indicated the College's concurrence of the importance of IPM education in a letter regarding the signing of the MOU when he wrote:

IPM is an excellent example of how society has to deal with complex environmental and economic problems. The Pennsylvania Department of Education has recognized this fact, and IPM is now awaiting approval as a learning objective in the K-12 curriculum in Pennsylvania [Appendix B]. This means that teachers throughout the Commonwealth will be compelled to use IPM in their lessons.

Purpose of the Study

Completion of this study will help to fulfill the needs of the new PDE state educational standards as well as address the concerns raised by past PAAE President Metzler. The purpose of this study was to develop and evaluate an IPM instructional unit for secondary science and agricultural science classes.
The instructional unit is designed to provide teachers with a guideline and a knowledge base to facilitate the integration of IPM material into their existing curriculum. The ultimate goal of the instructional unit is to provide teachers with a knowledge base that they can personalize to fit the needs and constraints of each individual class. Evaluation of the unit of instruction will be measured by changes in the student's knowledge and attitudes about IPM as a result of receiving instruction. The objectives of this study are as follows:

1. Determine student knowledge regarding IPM prior to receiving instruction.
2. Determine student attitudes regarding IPM prior to receiving instruction.
3. Determine student knowledge regarding IPM after receiving instruction.
4. Determine student attitudes regarding IPM after receiving instruction.

Variables Studied

Variables observed during this study include:

1. Comparison of the differences in IPM knowledge between secondary science and agricultural science students.
2. Changes in IPM knowledge as a result of participating in the instructional unit.
3. Changes in student attitudes regarding IPM as a result of instruction.
Limitations of the Study

In an effort to control teacher bias, it was the desire of the researcher that the same instructor present the material to both secondary science and agricultural science students. Although this method of selection helped to eliminate potential teacher bias, it limited the potential sample population. Using the directory of Agricultural Educators in Pennsylvania, a search was conducted to determine which instructors met this criterion. Of the 167 schools listed in the agricultural education directory, seven instructors, in seven different school districts, taught both secondary science and agricultural secondary science students. With the permission of their administration, five teachers agreed to be included as cooperators in the research.

Operational Definitions

Axiom--A statement accepted as true as the basis for argument or inference. An idea accepted or proposed as a demonstrable truth often as a part of a general theory.

Curriculum--An organized outline of subjects and learning objectives to be taught in a school or group of schools.

Curriculum Development--A comprehensive term that includes planning, implementation and development.

Curriculum Evaluation--The intermediate and final phases of development in which results are assessed and successes both of the learners and the programs are determined.

Curriculum Elements--Curriculum elements including objectives, content, methods, and evaluation.
Curriculum Model--A designed framework for curriculum development that provides a pattern to facilitate change.

Educational Goals--Broad statements of desired student achievements.

Envirothon--Environmental science competition for high school students that stresses knowledge in the area of soils, aquatics, forestry, wildlife and an issue of current environmental significance.

Evaluation--The collection and analysis of data for the purpose of making improvements to the unit of instruction.

External Summative Evaluation--An evaluation of the value of the instruction from the viewpoint of educators.

Formative Evaluation--Collection of evaluation data throughout the course of the study. Formative evaluation is used to make improvements during the instructional process.

Instructional Unit--An outline to guide and facilitate the instruction of a particular area of the curriculum.

Integrated Pest Management--A decision-making process for achieving long term environmentally sound pest suppression through the use of a wide variety of technological and management practices.

Internal Summative Evaluation--The assessment that takes place at the end of a unit. A posttest is the most frequently used means of this type of evaluation.

Learning Objectives--The desired learning outcomes of the students upon completion of instruction.

Memorandum of Understanding--Cooperative agreement between two agencies.
Pennsylvania Association of Agricultural Educators (PAAE)—The statewide professional association of instructors of agricultural-related education.

Pennsylvania Department of Agriculture (PDA)—The state agency that provided the funding to support this study.

Pennsylvania Department of Education (PDE)—The state department which administers the regulations of the State Board of Education and the federal government, as well as standards set by the Secretary of Education.

Pennsylvania State System of School Assessment (PSSA)—Examinations that will measure students’ attainment of the concepts outlined in the State Educational Standards

Pest—An unwanted plant, animal or organism that causes harm to humans, animals, crops, structures or the environment.

Pesticide—A substance used to kill, control, or in some way mitigate a pest population.

Pesticide Residue—The pesticide active ingredient which remains in or on the target after treatment.

Tolerance—The maximum amount of pesticide residue (active ingredient or certain metabolites) that may legally remain in or on a treated food commodity at harvest or slaughter. The Environmental Protection Agency establishes tolerances.

State Educational Standards—Standards which define what each student should know and do in a core set of subjects. Rigorous standards allow student achievement to be measured and will improve the academic performance of students and schools.
Common Acronyms Used in the Study

EPA--Environmental Protection Agency
FQPA--Food Quality Protection Act
FDA--Food and Drug Administration
IPM--Integrated Pest Management
LD50--The dose that produces 50 percent mortality in a test population.
MOU--Memorandum of Understanding
NEEA--National Environmental Education Act
PDA--Pennsylvania Department of Agriculture
PDE--Pennsylvania Department of Education
PSSA--Pennsylvania State System of School Assessment

Summary

The purpose of this study was to develop and evaluate an IPM instructional unit for secondary science and agricultural science classes. This evaluation was based on internal and external summative evaluations. The internal summative evaluations measured students' changes in IPM knowledge and attitudes as a result of receiving instruction. External summative evaluations were conducted to determine strengths and weaknesses of the unit from the viewpoint of educators.

Perhaps former EPA Administrator William Reiley said it best in remarks he made during a presentation at a 1990 national EPA meeting:

"In the end, environmental education boils down to a simple and yet profoundly important imperative: preparing ourselves for life and all its surprises in the next century. When the 21st century rolls around, it will not be enough for a few specialists to know what is going on while the rest of us wander around in ignorance."
Chapter 2
REVIEW OF LITERATURE

Introduction

Balancing chemical and non-chemical methods to manage pest problems is not a new concept for agriculturists and others in the pest control industry. For their own health and safety, and that of consumers that purchase their products, it is important that they are trained and properly educated. Consumer education is important for several reasons. Advances in technology allow for the detection of minute levels of pesticide residues on foods. Misrepresentation and confusion regarding these residues often results in consumer concern. In addition, perceived and actual misuse of pesticides has increased consumer awareness regarding the issue of pesticide use. Because of this increased awareness, consumers and environmentalists have put pesticide use under close scrutiny. These reasons and others cited in the literature that will be discussed in this chapter illustrate the need for an instructional Integrated Pest Management (IPM) unit.

By definition, IPM is the combination of multiple alternatives to achieve pest control. The broad-based comprehensive unit of instruction developed was expected to provide educational programming to both potential pest control managers and the consumers of their products and services. Therefore, this form of education should not be limited to agricultural science education, but should also be included in science education. To gain a better understanding of the issues surrounding the development of an IPM unit, this review of literature will focus on four areas:
1. The history, development, and importance of pests and pest control.
2. The current resources available for IPM education
3. The need for an instructional unit on IPM.
4. The process of curriculum development.

**History and Development of Pest Control**

Pest problems and pesticide use have had significant impacts throughout history. The bubonic plague and the Irish potato famine are probably the most well known examples of how pests have had a significant impact on history and society in general. Before the advent of synthetic chemicals, pest control was dependent on cultural methods and naturally occurring chemicals. Within the last 65 years, the pesticide industry has made major advancements in the development, use, and effectiveness of pesticides. In the 1930s, chemists and pest control specialists began to discover new and more effective substances to safeguard the food supply (Barrons, 1987).

However, the most dramatic increase in agricultural pesticide use has occurred since World War II. During this time the development of synthetic chemical controls was the pesticide industry’s initial priority.

After World War II, the development of synthetic organic pesticides significantly changed pest management practices. These new carbon-based compounds are derived from petroleum products. Although primarily developed for agricultural use, these compounds were also eventually put into service for home, industrial, and recreational use to meet public need for pest control. DDT is probably the most widely known pesticide. DDT served as the catalyst for the development of other synthetic pesticides.
In 1962, Rachel Carson first brought attention to human and environmental concerns related to pesticides. Consumer concern regarding pesticides increased significantly with publication of her book *Silent Spring*. The issues she raised and the resulting public concern eventually led scientists to shift their focus to the development of ecological, natural, or safer controls. Resistant varieties of plants, biological controls, and crop management techniques and other non-chemical methods were combined with chemical use to control pests. Some consider this the beginning of IPM.

**Increased Pesticide Use**

Pesticides have become an integral part of society for a variety of reasons. A surge in human population with a simultaneous demand for nutritional, economical, blemish- and pest-free foods and pest-free homes has led to the increased use of pesticides. As a result of society’s demands, nearly all households are in some ways affected by the use or presence of pesticides. Whether it is the flea collar on a pet or the bug spray used to repel insects, two studies indicate that over 90 percent of American households use some type of pesticide (Ware, 1983; EPA, 1992). In addition, not only does the average shopper want aesthetically pleasing produce, but they also expect low prices. Americans enjoy the privilege of quality food products at low market prices due, in part, to the use of pesticides. Approximately 2.5 million tons of pesticides are used worldwide each year. Pesticide use in the United States accounts for 1.3 million tons of the world’s use, with over 70 percent of the pesticides used in agricultural production and processing (Ware, 1989).
In addition, as documented previously the vast majority of consumers use pesticide products (EPA, 1990). Most consumers make their household pesticide purchases on impulse, without prior selection or authoritative information about the method of application, safety, effectiveness, or storage. Thus, even homeowners need to know what pesticides are, what they do and when to use them for the most effective yet safest results (Ware, 1983). Just as important, consumers and pest control managers need to be aware of the existence of viable alternatives to pesticides.

Although pesticides provide the producer and consumer with many benefits, their incorrect or unnecessary use is not without risk. Misapplications, whether intentional or due to lack of education, are the most drastic example of such risk.

Need for an Instructional Unit on IPM

Although the practice of IPM is not a new concept, curriculum and educational materials in this area are limited. A search was undertaken by the researcher to determine the availability of materials that could be used as resources by instructors. Many available resources were found such as chapters in textbooks, short fact sheets, and other resources, but, an organized, up-to-date, unit of instruction was unavailable. The literature, however, cites many examples suggesting the need for these educational materials. In 1987, agricultural education faculty at the University of Georgia initiated a futures-oriented series of studies of curriculum. Studies that have been completed in the areas of greenhouse crops list Integrated Pest Control systems as an important future curriculum (Iverson, 1993).
In 1989, Rubba and Wiesenmayer of the Penn State University Center for Education in Science, Technology and Society documented the need for instructional materials for high school classrooms in the area of pesticide education. They stated the following in their proposal for instructional development concerning pesticides and society (Rubba & Wiesenmayer, 1989):

“Educating the public and empowering citizens with the knowledge, skills, and motivation to resolve issues related to pesticides in a responsible manner remains a challenge.” Unfortunately, due to budgetary constraints, Rubba and Wiesenmayer’s proposal was not funded and the materials were never developed.

In 1990, the National Environmental Education Act (NEEA) was signed into law. One of the main objectives of NEEA is to increase public understanding of the environment and related issues at all grade levels. The NEEA mandates that the Environmental Protection Agency (EPA) establish an Office for Environmental Education. The EPA believes that taking a leadership role in promoting more environmentally-oriented scientific and technical education is fundamental to accomplishing its mission of protecting the public from environmental hazards and enhancing the quality of the natural environment. In the EPA’s strategic plan for establishing the Environmental Education Program, the agency indicates “a number of problems which many federal, state, and local organizations are also addressing as part of a national effort to improve our youth’s scientific and technical skills” (EPA, July 1990, draft). The draft states that “these problems include the lack of teaching material which integrates scientific and technical subjects into the teaching of other disciplines.”
In their 1991 article, *Sustainable Agriculture: An Essential part of the In-
Agriculture Curriculum*, Marshall and Herring list pest control and chemical
use as one of the six areas being researched and debated. It is their opinion
that IPM is an issue relative to sustainable agriculture. Marshall and Herring
conclude:

The inclusion of sustainable agriculture in the curriculum is
essential. This will probably not occur, at least at the secondary
level, as a separate course. Rather, as units in agriculture are
taught, discussions of these issues should be integrated. This will
result in a generation of graduates knowledgeable of the critical
issues facing agriculture in the 21st century. (Marshall & Herring,
1991, p. 12)

As a major focus of a Masters of Education, this researcher developed a
pesticide safety curriculum (Hoffman, 1992). At the request of the Pennsylvania
Department of Agriculture, the pesticide safety curriculum served as the
resource materials for the 1992 Pennsylvania Envirothon “current issue station.”
The Envirothon is a science-based competition that teaches students about
environmental issues. The current issue topic is selected based on what is
perceived as a pressing environmental concern. Evaluations completed by
secondary science and agricultural science instructors participating in the
program were favorable. However, the overwhelming suggestion for
improvement was to include information regarding alternatives to pesticide use
for pest control (Envirothon Committee, personal communication). In essence,
these suggestions were stressing the desire for an IPM curriculum.

Further justification of the need for an IPM instructional unit is
illustrated by several recent actions. IPM was included as the current issue
Departments of Education and Agriculture, along with The Pennsylvania State
University’s Colleges of Agricultural Sciences and Education, signed a Memorandum of Understanding (MOU) to collaborate in bringing IPM instruction into K-12 schools in Pennsylvania (Appendix C). Currently, the Pennsylvania Department of Education is in the process of developing state standards for secondary school curriculum, including standards for IPM education. With the adoption of these standards, IPM will become a core academic subject in the public school curriculum.

Establishment of State Standards

State legislatures throughout the country consistently demonstrate a penchant for curriculum making. Mandates from the legislature in some cases with leadership from the executive branch have been the prime movers for reform in the 1980’s and early 1990’s. (Olivia, 1997, p. 79)

In the past several years, there has been growing concern in Pennsylvania that too many children are leaving school without the skills they need to become more productive adults. According to statistics cited by the Pennsylvania Department of Education (PDE, 1999a, p. 1):

1. Sixty percent of voters believe public schools set their standards of performance too low.
2. More than 85 percent of parents approve of holding students to higher academic standards and measurements.
3. Fifty-two percent of teachers say that academic standards in their schools are too low.
4. Eighty percent of businesses say that there should be educational standards, and 75 percent of businesses believe that businesses should become more involved in setting standards.
One way that educators, parents and members of the wider community in Pennsylvania have addressed these concerns is to help students learn at higher levels than ever before. Standards are a critical step in addressing these concerns in the Commonwealth.

In 1996, the Governor’s Advisory Commission on Academic Standards was established. The purpose of the Commission was to recommend “a rigorous set of academic standards, the achievement of which demonstrates the attainment of high levels of student competency in core academic subjects” (PDE, 1999b). Academic standards are expectations of student knowledge. Academic standards express what it is that students are expected to know and do when essential concepts and skills related to each academic discipline are acquired. Academic standards, sometimes referred to as content standards, provide consistent targets for students, parents and teachers to work toward (PDE, 1999a).

The Commission did not write the standards. Instead, the Commission was charged with the responsibility to “obtain and consider ideas and proposals regarding academic standards from citizens throughout the Commonwealth, particularly parents and community and business leaders” (PDE, 1999b). An educational consulting firm was hired to provide the commission with assistance, which included developing materials as well as external review of drafts of the standards to ensure that they were competitive with standards developed elsewhere. Drafts of Pennsylvania’s academic standards were held up to four criteria by the Governor’s Commission: the standards had to be rigorous, measurable, applicable to the world in which we live, and clearly written. The standards proposed by the Commission aim to
ensure that students who become proficient in the skills outlined in these standards will be competitive with students anywhere. It is the opinion of the Commission that students need to be able to make the connection between what it is that they are expected to learn in school and what is critical to success in life.

The Environment and Ecology standards are grounded in the complexity of the world we live in and our impact on sustainability. The goal of the Environment and Ecology standards is to examine the world with respect to the economic, cultural, political, and social structure as well as natural processes and systems. This integration across systems is what sets this academic area apart from all others. As students master these standards, they will become aware of the role they play in the community in reaching decisions related to the environment (PDE, 1999a). Integrated Pest Management is one of nine core areas of the Environment and Ecology standards. The IPM standards spell out what a student should know and be able to do by the completion of specific grade levels. Students' attainment of the concepts outlined in the standards will be measured by the Pennsylvania System of School Assessment (PSSA) tests. Although local school districts are not mandated to strictly follow the standards, PSSA tests will be designed around the academic standards. Beginning in the 2002-2003 school year, students will be required to attain one of four categories of achievement of academic performance on PSSA tests. The four proficiency levels--Advanced, Proficient, Basic and Below Basic--will be developed before the 2002 school year. The State Board of Education and PDE, in consultation with educators, parents, community and business leaders will meet to establish performance
levels and determine benchmarks and the content of each level of proficiency (PDE, 1999a). Even if schools choose to develop their own assessment exams, they must be aligned with the state standards.

In July of 1998 PDE’s Office of Environment and Ecology, Bureau of Curriculum and Academic Services (Appendix B) released the final report of a teacher survey regarding the Environment and Ecology standards. The objective of the study was to determine which of the components of the Pennsylvania Department of Education’s proposed academic standards for Environment and Ecology were currently being taught to public school students in grades four, seven, ten and twelve. The survey was developed based on the standards and distributed to a representative sample of Pennsylvania public school teachers. A statistical analysis of the survey results was completed to determine:

1. How many schools within each grade covered the components in the proposed standards,

2. Whether there was a relationship between a component being covered in a school and the school’s being in a rural, suburban and urban setting, and

3. If there was a relationship between school setting and the average score for the nine standard areas.

The final sample had an overall return rate of 56 percent. Based on the overall means calculated for each of the nine Environment and Ecology Standards areas across all four grades, agricultural diversity and integrated pest management rank first and second as the standard areas least frequently taught (Appendix B). There is also evidence of a trend toward these concepts
being taught in suburban rather than urban schools. In addition, the survey indicates that these concepts are more likely to be introduced in seventh, tenth and twelfth grades and not in fourth grade. There were ten IPM concepts included in the study (see Table 1).

Of these ten IPM concepts, the survey indicates that none are taught by the majority of schools in the study. Only one of the IPM concepts that is to be addressed at the fourth grade level was included in the survey. The schools/teachers indicating that the concept is either not taught or not completely covered represent 92 percent of all respondents. Seventh grade schools/teachers responding to the three IPM concepts in the survey indicated that a significant majority either do not teach or only introduce, but do not completely cover, these concepts. Although there was a noticeable increase in the number of schools that indicated they covered the three concepts surveyed for tenth grade students, over 70 percent of the schools/teachers indicated that the concepts were either not taught or only introduced and not completely covered. Similar results were indicated at the twelfth-grade level.

Curriculum Development Philosophies

Although it will soon be mandated by the new State Standards, curriculum change occurs at best gradually. In his 1997 article, A Participatory Approach to Curriculum Development, Van Crowder notes that a major influence on a curriculum is the philosophical framework, or educational ideology, which is adopted during the process itself. Van Crowder identifies two philosophical approaches, classical/rational approach and the participatory approach. Van Crowder describes the classical/rational approach as a more
<table>
<thead>
<tr>
<th>Grade 4 - Concept(s):</th>
<th>Concept not taught</th>
<th>Concept introduced but not completely covered</th>
<th>Concepts are taught</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identification pests, pest controls, and integrated pest management practices inside</td>
<td>9%</td>
<td>19%</td>
<td>21%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Grade 7 - Concept(s):</th>
<th>Concept not taught</th>
<th>Concept introduced but not completely covered</th>
<th>Concepts are taught</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beneficial and harmful effects of pests in different locations</td>
<td>13%</td>
<td>50%</td>
<td>35%</td>
</tr>
<tr>
<td>How pest management impacts the environment and how integrated pest management has been influenced by policies and technologies over time.</td>
<td>37%</td>
<td>48%</td>
<td>15%</td>
</tr>
<tr>
<td>Various pest management practices used in different communities and the long-term effects of these practices over time.</td>
<td>56%</td>
<td>35%</td>
<td>7%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Grade 10 - Concept(s):</th>
<th>Concept not taught</th>
<th>Concept introduced but not completely covered</th>
<th>Concepts are taught</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identification of species which are pests in some areas of the world and are not pests in other areas</td>
<td>27%</td>
<td>47%</td>
<td>25%</td>
</tr>
<tr>
<td>Identification of the health risks and benefits associated with pest control.</td>
<td>25%</td>
<td>47%</td>
<td>27%</td>
</tr>
<tr>
<td>The impact of integrated pest management and how it changes over time.</td>
<td>40%</td>
<td>44%</td>
<td>15%</td>
</tr>
</tbody>
</table>
### Table 1. Continued.

<table>
<thead>
<tr>
<th>Grade 12 - Concept(s):</th>
<th>Concept not taught</th>
<th>Concept introduced but not completely covered</th>
<th>Concepts are taught</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identification of threshold limits of pests and the need for intervention in a managed environment.</td>
<td>24%</td>
<td>48%</td>
<td>27%</td>
</tr>
<tr>
<td>The relationship between integrated pest management and political and economic processes.</td>
<td>42%</td>
<td>39%</td>
<td>19%</td>
</tr>
<tr>
<td>The historical significance of integrated pest management on society.</td>
<td>47%</td>
<td>36%</td>
<td>17%</td>
</tr>
</tbody>
</table>

The percentages of teachers/schools which responded to each question as “concept not taught,” “concept introduced but not completely covered,” and “concepts are taught” are listed. Not all teachers/schools responded to each question/statement; therefore, percentages for each area do not always total 100%.
product-oriented method. This is seen as a more top down philosophy with curriculum aims and objectives set by professionals. The underlying philosophy is that all interested groups are in agreement as to the common educational goals, and therefore, dialog between groups is not necessary. The participatory/interactive approach follows a more process-oriented philosophy. There is a greater emphasis on participation and interaction among educational stakeholders. The goal is to stimulate an interactive process that allows stakeholders to voice their perceptions of the ideal curriculum and to make those ideas compatible and modify them to produce the curriculum.

At the 1991 FAO Expert Consultation on agricultural education, it was recommended that institutional approaches to decision making incorporate “a more participatory approach to the planning process” and that “feedback from the users...in curriculum review and revision offers an effective way of keeping research and teaching relevant and interesting” (Van Crowder, 1997, p. 1). As described by Van Crowder, in practice the participatory philosophy is based on an interactive approach which gathers input from stakeholder groups. Van Crowder notes that this can be “guided by outside curriculum development experts.” However it makes provisions for stakeholder involvement in curriculum innovation.

Van Crowder notes that, “although there are distinct philosophical differences between the two, they are not complete opposites and curriculum planning may include elements of both (Van Crowder, 1997, p.1). The underlying philosophical approach of curriculum seems to often be seen in the model used during the curriculum development process.
The Process of Curriculum Development

To echo the words of curriculum leader Hilda Taba:

the total job of planning a unit needs to be broken into systematic steps to assure orderly thinking, to make possible a systematic study of the need to be in an orderly sequence. Each step should prepare for the next, which would otherwise be difficult. (Taba, 1962, p. 458)

All curriculum, no matter what the underlying philosophy, is composed of certain elements. A curriculum usually contains a statement of aims and specific learning objectives; it indicates some selection and organization of content; it either implies or manifests certain patterns (methods) of learning and teaching, and, finally, it includes an evaluation of its outcomes (Taba, 1962). In his book Developing the Curriculum, Peter F. Olivia lists several “generally accepted axioms that apply to the curriculum field that may serve to guide efforts that curriculum workers make for the purpose of improving curriculum” (Olivia, 1997, p. 28). Olivia defines an axiom as a guideline that establishes a frame of reference for workers seeking ways of operating and solving problems. Several of the axioms Olivia discusses deal directly with the change process as it relates to curriculum development. In his first axiom, he states that change is inevitable and necessary. He pursues this thought by charging that change in the form of responses to contemporary problems must be foremost in the minds of curriculum developers. In axiom three, he suggests that changes made at an earlier period of time can exist concurrently with newer curriculum developed later. He contends that curriculum changes rarely start and end abruptly, but rather are phased in over time. During this phase-in period changes may overlap and coexist for long periods. In his
seventh axiom, Olivia states that curriculum development is a never-ending process. In his tenth and final axiom, Olivia notes that most curriculum planners begin with already existing curricula. Therefore, it is his position that it would be more accurate if, instead of talking about curriculum organization, we talked about curriculum reorganization. He steadfastly proclaims that the investment of thought, time, money, and work by previous planners cannot be discarded (Olivia, 1997).

**Curriculum Models**

In his ninth axiom relative to curriculum change, Olivia recommends that systematic curriculum development is more effective than trial and error. He suggests that curriculum planners are more likely to be productive and successful if they follow an agreed-upon model for curriculum development that outlines or charts the sequence of steps to be followed (Olivia, 1997). Tyler's curriculum model is the most common model in the field of curriculum development (Brady, 1990). Tyler's model is commonly known as the Objectives Model. His rational for the model is based on four central questions:

1. What educational purposes should the school seek to attain?
2. What educational experiences can be provided that are likely to attain these purposes?
3. How can these educational experiences be effectively organized?
4. How can we determine whether these purposes are being met?

When reformulated, these four questions outline the Objectives Model (Figure 1).
A problem with Tyler’s model is there is little flexibility to vary from the sequence of the model. Posner and Rudnitsky caution their readers to be “careful not to fall into the trap of thinking about course design in a strictly linear manner.” It is also their philosophy that

There is no reason to insist on any degree of finality to a course planning step so long as we remember that we will be returning to that step at a later time equipped with new ideas and clearer thinking. (Posner & Rudnitsky, 1994, p. 11)

This philosophy is more in line with the Taba’s curricular model, which Brady labels as the Interaction Model (Figure 2). The primary difference between these two basic philosophies is the relationship between the curriculum elements. Both models contain many of the same elements; however, Taba’s model is a more flexible process that allows curriculum developers to begin with any of the four elements. Conversely, Tyler’s model is strict in the assertion that curriculum development must begin with the formulation of objectives and proceed in a strictly linear fashion.

Figure 1. Tyler’s Objectives Model (Brady, 1990, p. 58).
Brady conducted a study in 1981 to determine which of the two models was used more frequently by teachers (Brady, 1990). Her findings indicated that teachers used the two models interchangeably. A second study conducted in 1989 by Brady showed that, of the curriculum elements, 86.9 percent of the teachers sampled began curriculum development by giving consideration to content. Teachers in the sample who followed three major sequences among the curriculum elements accounted for 95.2 percent of the sample (Brady, 1990). These sequences included:

1. Content - Objectives - Methods - Evaluation (51.2 percent)
2. Content - Methods - Objectives - Evaluation (30.9 percent)
3. Objectives - Content - Methods - Evaluation (13.1 percent)
Although she concedes that many curricula text advocates the use of an objectives model, it is Brady’s premise that there is not one right way to develop a curriculum provided that there is an obvious link and consistency between elements of the curriculum in question (Brady, 1990). It is Brady’s philosophy that models are inevitably incomplete; they do not and cannot show every detail and every nuance of a process as complicated as curriculum development.

Theoretical models on the subject of curriculum development seem to be plentiful, but the actual how-to-do-it approaches to curriculum development are more difficult to locate (Zenger & Zenger, 1982). Dick and Carey’s (1996) systems model approach is a performance-oriented model stressing the identification of skills students need to learn and the collection of data from students to revise instruction (Figure 3). The systems model focuses on what the learner is to know or be able to do when the instruction is concluded. The systems model stresses all of the components; the objectives, content, and evaluation are linked. Dick and Carey state that the most important reason for the success of the systems model is that it is an empirical and replicable process.

Instruction is designed not to be delivered once, but for use on as many occasions as possible with as many learners as possible. Because it is ‘reusable,’ it is worth the time and effort to evaluate and revise it. In the process of systematically designing instruction, data are collected to determine what part of the instruction is not working, and instruction is revised until it does work. (Dick & Carey, 1996, p. 336)

Dick and Carey contend that, because of the previously mentioned characteristics, the systems approach is valuable to instructors who are
Figure 3: Dick and Carey’s Systems Approach Model
interested in successfully teaching basic and higher level competencies to learners. They note that the competency-based approach has been a very natural and widely adopted approach among educators. However, they concede that the most numerous applications of the systems model approach may be found in industry and the military.

Zenger and Zenger developed a process that brings together the parts of the systems model approach used more by the business world, and also includes the basic curriculum and development process used by educators (Zenger & Zenger, 1982). Zenger and Zenger’s process is very similar to that of Dick and Carey’s systems model. However, it is more of a step-by-step, check list approach which provides a more sequential structure (Appendix D). The ten-step curriculum planning process developed by Zenger and Zenger can be selectively used to develop small segments of the school curriculum, add to a program that already exists, or create an entire school curriculum (Zenger & Zenger, 1982). Zenger and Zenger emphasize that use of this model may or may not include all ten steps and may begin or end with any one step in the process. There are ten steps in Zenger and Zenger’s model: identify curricular need, develop curricular goals and resources, identify resources and constraints, organize curricular committees, establish roles of personnel, identify new curricula, select new curricula, design new curricula, implement new curricula, and evaluate new curricula. For the purpose of this research, eight of the ten steps were used (Figure 4).

Zenger and Zenger’s model closely aligns with what Van Crowder notes as the “systematic planning approach” relative to the participatory philosophy of curriculum development. Van Crowder indicates that the participatory
approach follows a structure for decision making and action as well as a logical sequencing of curriculum development phases without being rigid. Van Crowder also notes, “It includes the preparation by the curriculum development team of an action plan for managing the curriculum process which identifies the human and financial resources available and needed to carry out the plan” (Van Crowder, 1997, p. 2).

Summary

The review of literature documents the need for the development of an IPM instructional unit. The review of curriculum philosophies and models
illustrates the importance of a sequential approach to development of the instructional unit. The demand for environmental education materials is just beginning. In a world of increased awareness and interest in environmental issues, such as pesticide concerns, there is a pressing need for organized curricula. It is no longer enough to educate only the pesticide applicator whose livelihood depends in part on the safe use of pesticides. Now, we must also educate the consumer. Education will allow consumers to make their decisions regarding pesticides based upon balanced knowledge. In addition, measuring changes in student’s attitudes as a result of receiving instruction may determine if student’s perceptions have changed. As Van Crowder notes, “The tasks and challenges for developing curricula that addresses the problems of sustainable agriculture and rural development are great. As a first step, we should recognize that we cannot afford to educate students with the curricula and methods of the past” (Van Crowder, 1997, p. 3).
Chapter 3

METHODS AND RESEARCH DESIGN

Integrated Pest Management (IPM), the combined use of multiple alternatives for pest control, is by no means a new concept. For decades progressive agriculturists have been balancing chemical and non-chemical methods of pest control to reach the most cost-effective, practical solutions to pest problems. However, due in part to consumer concerns, the use of pesticides has brought increased attention to the use of IPM in areas other than traditional production agriculture, including lawn care and structural pest control. In addition, many states, including Pennsylvania, have enacted, or are in the processes of developing, legislation mandating the use of IPM practices in public schools. Furthermore, statewide science and environmental education standards, currently in the final stages of development in Pennsylvania, include learning objectives relative to IPM. All of these factors contribute to the need for the development and evaluation of an IPM instructional unit.

This study documents the development and evaluation of an IPM unit of instruction for secondary school environmental science and agricultural science classes. Specifically, the study measures changes in students’ attitudes and knowledge about IPM as a result of receiving instruction. The sequential procedures of the study were to:

1. Revise the existing Pesticide Safety Education curriculum to include IPM related lessons.
2. Develop and collect materials to support classroom instruction.
3. Field test materials to gain additional insights for improvement.
4. Make improvements to the unit of instruction based on the recommendations of a panel of experts and field test evaluations.
5. Pretest students to determine their knowledge regarding IPM prior to receiving instruction.
6. Pretest students to determine their attitudes regarding IPM prior to receiving instruction.
7. Provide instruction to high school science and agricultural science classes using the curriculum materials.
8. Posttest students to determine their knowledge regarding IPM after receiving instruction.
9. Posttest students to determine their attitudes regarding IPM after receiving instruction.
10. Conduct external summative evaluations to solicit input from instructors who participated in the research, content experts, and curriculum specialists.

**Variables Studied**

Variables observed during this study include:

1. Comparison of the differences in IPM knowledge between secondary science and agricultural science students.
2. Changes in IPM knowledge as a result of participating in the instructional unit.
3. Changes in student attitudes regarding IPM as a result of instruction.
Development of the Unit of Instruction

Using the Pesticide Education Manual (Hock, 1996), developed by The Pennsylvania State University’s Office of Pesticide Education, and the Environmental Protection Agency’s (EPA) Citizens Guide to Pesticides and Pest Control (EPA, 1995) as the primary references, the existing Pesticide Safety unit was revised. The revised unit included the following new areas of instruction: a) History of IPM, b) Introduction of Pest Management, c) Alternatives to chemical pest control, and d) Reduction of potential pest problems (Appendix A). Basic lesson plan outlines, lecture guides, audiovisual materials, and other reference materials were developed or collected for inclusion with the unit. In addition to the Pesticide Education Manual and Citizens Guide to Pesticides and Pest Control, references include relevant fact sheets, brochures, industry and public interest advocacy group materials, and audiovisual materials (Table 2). Materials were either developed by the researcher or collected from universities, governmental agencies, or public interest groups from across the United States. The materials for the four new areas of instruction listed above which were developed by the researcher were reviewed by members of the Penn State University IPM program and the Pennsylvania Department of Agriculture IPM program.

Panel of Experts

A panel of experts evaluated the instructional unit, knowledge instrument, and attitudinal Likert-Scale instrument. The panel consisted of a member of the Penn State IPM staff, a member of the Pennsylvania Department of Agriculture IPM staff, and teachers who previously used the
Table 2. IPM Instructional Unit Resource List.

<table>
<thead>
<tr>
<th>Resource</th>
<th>Publisher/Author</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban Pest Management, Strategies for Managing Pests In and Around the</td>
<td>Cornell Cooperative Extension, Cornell University</td>
</tr>
<tr>
<td>Home, Fact Sheet 1</td>
<td></td>
</tr>
<tr>
<td>Common Sense Methods of Managing Pests, Pennsylvania Department of</td>
<td></td>
</tr>
<tr>
<td>Agriculture</td>
<td></td>
</tr>
<tr>
<td>BayScapes Action Guide, Home Landscape Audit</td>
<td>Alliance for the Chesapeake Bay, BayScapes packet</td>
</tr>
<tr>
<td>Integrated Pest Management, A Homeowner’s Guide</td>
<td>Alliance for the Chesapeake Bay, Bayscape packet</td>
</tr>
<tr>
<td>Lawn and Garden Pesticides</td>
<td>Wisconsin Extension Office, Order #GWQ011</td>
</tr>
<tr>
<td>Pesticides and Water Quality</td>
<td>Wisconsin Extension Office</td>
</tr>
<tr>
<td>EPA Citizen’s Guide to Pest Control and Pesticide Safety</td>
<td>U.S. EPA</td>
</tr>
<tr>
<td>The Pennsylvania State University, Office of Pesticide Education is the</td>
<td>for the following materials:</td>
</tr>
<tr>
<td>source for the following materials:</td>
<td></td>
</tr>
<tr>
<td>Pesticide Education Manual</td>
<td></td>
</tr>
<tr>
<td>Food Quality Protection Act Video</td>
<td></td>
</tr>
<tr>
<td>Circle of Food Safety Fact Sheets</td>
<td></td>
</tr>
<tr>
<td>Fate of Pesticides Slide Set, Penn State University Office of Pesticide</td>
<td>Education</td>
</tr>
<tr>
<td>Education</td>
<td></td>
</tr>
<tr>
<td>AgChem Fact Sheet #7, Toxicity and Potential Health Effects of Pesticides</td>
<td>Order #UO198</td>
</tr>
<tr>
<td>AgChem Fact Sheet #8, The Fate of Pesticides in the Environment, Order #</td>
<td>UO199</td>
</tr>
<tr>
<td>UO199</td>
<td></td>
</tr>
<tr>
<td>AgChem Fact Sheet #13, The Food Quality Protection Act, Order #UO206</td>
<td></td>
</tr>
<tr>
<td>Materials for Exposure Experiment:</td>
<td></td>
</tr>
<tr>
<td>Fluorescent Dye, Glo Germ</td>
<td>1-800-842-6622</td>
</tr>
<tr>
<td>Blacklight: Small blacklights at your local Wal-Mart or similar store</td>
<td></td>
</tr>
<tr>
<td>Personal Protective Clothing, Gemplers or similar supplier</td>
<td></td>
</tr>
</tbody>
</table>
instructional unit. The panel of experts was asked to review the instructional unit and instrument for content and face validity.

**Pilot Testing**

An appropriate population appeared to present itself when representatives of the National Envirothon asked permission to use the curriculum as resource materials for the 1997 Envirothon. However, because of the competitive nature of the Envirothon, and several intervening variables, the use of this population was not appropriate. Instead, this group did provide the opportunity to pilot test the instructional unit and gain valuable insights. The IPM instructional unit was pilot-tested in over 350 schools during the 1997 Pennsylvania Envirothon program. As a result of comments and suggestions for improvement (Appendix E), minor revisions were made to the instructional unit. The evaluation instrument was pilot tested at the Pennsylvania State Envirothon in May 1997. Based on student responses, the instrument was evaluated for content validity. As a result of the evaluation, minor changes were made in fewer than 20 percent of the items on the instrument.

**Course Evaluation**

Cronbach identifies three uses for evaluation: a) course improvement, b) decisions about individual students, and c) administrative regulation (Cronbach, 1963). Cronbach’s view regarding the purpose of evaluation for course improvement is to gather information that will help decide which parts of the course need to be improved. From Cronbach’s perspective, the purpose of evaluating individual students is to gather information that will allow for
the grading or grouping of the individual student. Further, the purpose of evaluation for administrative regulation is to determine the merit of curriculum materials. Cronbach argues that using evaluation for course improvement contributes more toward improving education than do the other uses of evaluation. One of the purposes of this study was to evaluate the instructional unit to determine where improvements were necessary.

**Development of the Instruments**

Survey instruments were designed to measure students’ changes in IPM knowledge and attitude as a result of receiving instruction. To measure the change in students’ knowledge, examination questions (Appendix F) were developed based on the learning objectives presented in each lesson. Care was taken to assure the objectives of the lessons were addressed in the examination questions. The majority of the exam questions were multiple choice. The correct responses for the multiple-choice questions were randomly placed among the distracters so that no response pattern existed. The examination also contained questions that required students to be able to research a pesticide label and a Material Safety Data sheet to locate and identify the required information. The examination was administered as a pretest to measure the students' knowledge prior to the instruction and the same examination was administered again upon completion of the unit.

Changes in students' attitudes regarding IPM were measured by administering a five-point Likert-type Scale attitudinal instrument (Appendix F) prior to and upon the completion of the IPM unit of instruction. Students were asked to indicate their level of concurrence with 29 statements regarding
their attitude toward different IPM concepts. Possible responses ranged from Strongly Disagree to Strongly Agree. The option also existed for students to respond in a neutral manner. This scale is used to register the extent of agreement or disagreement with a particular statement which serves as an indication of an attitude, belief, or judgment (Tuckman, 1994).

**Population and Sample**

The target audience was secondary school science and agricultural science students in grades 10 through 12 from high schools in Pennsylvania. The sample was selected to reflect Peter Olivia's notion that a curriculum needs to be tested in different classrooms and under varied conditions to establish the curriculum validity and teachability and to set upper and lower limits of required abilities. It is Olivia's contention that this testing should suggest appropriate modifications and alternate selection of content and learning experiences and materials to accommodate variations in student population (Olivia, 1997). In an effort to control teacher bias, it was the desire of the researcher that the same instructor present the material to both science and agricultural science students. Using the Directory of Agricultural Educators in Pennsylvania, a search was conducted to determine which instructors met this criterion. Seven instructors, in seven different school districts, met the criterion. A letter describing the study, the lessons, and the subject matter to be presented was sent to prospective instructors soliciting their participation. With the permission of their administration, five teachers agreed to be included as cooperators in the research.
Human Subject Clearance

The researcher filed the appropriate forms with The Pennsylvania State University, Office for the Protection of Human Subjects. An expedited type of review was requested since the study involved minor subjects (Appendix G). Upon receiving clearance for study, the researcher visited each of the participating classes for one class period explaining the subject matter, describing the importance of their participation in the research, and answering question students may have had pertaining to the study. The regular classroom instructor distributed and collected the necessary informed consent paperwork prior to students' participation in the study.

Research Design

The study was conducted using a quasi-experimental design. The inability to randomly assign subjects to treatment groups necessitated this type of design. Specifically, the Nonequivalent Comparison Group design was used to measure the change in student knowledge and attitude regarding IPM (Campbell & Stanley, 1963). This is one of the most widespread experimental designs in educational research. The distinguishing characteristics of this design are administration of a pretest and posttest to both groups, and non-random assignment of subjects to groups. Achievement in the cognitive domain is ordinarily demonstrated in school by pupil performance on written tests administered to a group--usually, but not always, an entire class. The design can be diagrammed as follows:
Where:

OAK1 = Pretest for Agricultural Science students' knowledge and attitude regarding IPM.

OSK1 = Pretest for Secondary Science students' knowledge and attitude regarding IPM.

X = Treatment (IPM unit of instruction)

OAK2 = Posttest for Agricultural Science students' knowledge and attitude regarding IPM.

OSK2 = Posttest for Secondary Science students' knowledge and attitudes regarding IPM.

------- = Nonequivalent groups

This model provides the basis to address the research questions:

1. Will there increase in science and agricultural science students' knowledge of IPM as a result of receiving instruction?

2. Is there a change in science and agricultural science student attitudes relative to IPM as a result of completing the IPM unit of instruction?

3. Is there a difference between science and agricultural science student increase knowledge and changes in attitude relative to IPM as a result of completing the IPM unit of instruction?

Collection of data in this manner will also allow for individual item analysis to determine which area(s) students had difficulty mastering. Availability of this information will facilitate the improvement of the instructional unit.
Conduct of the Study

Inservice training was provided for teachers administering the IPM unit of instruction. Materials necessary to conduct each lesson were provided to the instructors. The instructors were given copies of the Pesticide Education Manual and Citizens Guide to Pesticides and Pest Control for each student. A copy of all audiovisual materials listed in the lesson plans was also provided. Lesson plans, which clearly outline the learning objectives for each lesson, were provided. Lecture guides for teachers consisted of information necessary to provide students with knowledge to address each learning objective. Student learning guides were developed to supplement lecture and audiovisual material. These learning guides were designed to help students identify key points in the lectures and audiovisual presentations. The guides provided the students with outlines to follow the lecture and questions to answer regarding information presented in the audiovisual materials. The teachers administered the pretest and attitude instrument prior to the start of the IPM unit. Upon completion of the nine-lesson IPM unit, the instructor administered the posttest and attitude instrument. The instructor forwarded the data from participating students to the researcher for data analysis. Participating teachers were asked to complete a written evaluation of the unit.

Data Analysis

The main threat to the internal validity of nonequivalent control-group experiments is the possibility that group differences on the posttest are due to preexisting group differences rather than to a treatment effect. The preferred statistical method of data analyses is analysis of covariance. Statistically one
justifies the use of covariance when the pretest, which measures the preexisting knowledge, is highly correlated with the posttest. High correlation is defined as r-values of ±.7 or higher (Hinkle, Wiersma & Jurs, 1988). In this study the correlation between the IPM knowledge pretest and posttest was r=.097, p=.787. Thus, the original planned use of analysis of covariance was not statistically warranted. Instead the IPM knowledge data were analyzed using independent and dependent t-tests. The specific data analysis techniques used are summarized in Table 3.

Table 3. Summary of Data Analysis Techniques.

<table>
<thead>
<tr>
<th>Research Question</th>
<th>Variables</th>
<th>Analysis Technique</th>
</tr>
</thead>
<tbody>
<tr>
<td>What are the differences in IPM knowledge between science and agricultural science students?</td>
<td>y=IPM knowledge pretest scores (I/R) y=IPM knowledge posttest (I/R) x=Student group with 2 levels (Nominal)</td>
<td>Independent t-test Independent t-test</td>
</tr>
<tr>
<td>What differences exist in changes of IPM?</td>
<td>y=Attendence</td>
<td>Independent t-test</td>
</tr>
<tr>
<td></td>
<td>y=Raw gain score in IPM knowledge (I/R) x=Test Administered (Pre or Post)</td>
<td>Paired t-test</td>
</tr>
<tr>
<td>What changes occur in attitudes towards IPM concepts for the two groups?</td>
<td>y=attitude response on a 1-5 Likert scale x=student group with two levels</td>
<td>Descriptive statistics including mean, S.D., and change</td>
</tr>
</tbody>
</table>

Statistical significance was established using alpha ≤ .05
Chapter 4

FINDINGS

The process of evaluation is the process of determining to what extent the objectives are being achieved through the selected content and method. Evaluation for course improvement involves gathering information that will be useful in deciding which aspects of a course can and should be improved. (Posner, p. 152)

This chapter reports the findings of the research in three sections, student knowledge, student attitude and external summative evaluations. Through the data analysis, conclusions were developed as a basis for recommendations related to the enhancement of the IPM instructional unit.

Student Knowledge

A statistical analysis of secondary science and agricultural science students pretest and posttest scores was conducted to answer two basic research questions. Research question one focused on changes in student knowledge by examining changes in pretest and posttest scores. Mean scores and standard deviations for pretest and posttest scores (see Table 4) indicate an average of 31.6% and 22.5% increase in knowledge scores for secondary science and agricultural science students respectively. Because of the relatively large standard deviation values for the pretest scores, Box and Wisker plots (see Figure 5) were developed to identify outliers, and to more thoroughly assess the variability of the data. With the exception of four values in the pretest and one value in the posttest, all other values are within 1.5 standard deviations of the median. Thus, based on the skewness values and the Box-and-Wisker plots (see Figure 6), the researcher deemed that the pretest and posttest knowledge values were fairly normally distributed (Huck & Cormier, 1996).
Table 4. Summary Information for Pretest and Posttest Knowledge Percentage Correct Values Reported by Student Group.

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>Median</th>
<th>S.D</th>
<th>Skewness</th>
<th>Low</th>
<th>High</th>
<th>Change from Pretest to Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secondary Students</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pretest</td>
<td>77</td>
<td>32.7</td>
<td>31.4</td>
<td>15.2</td>
<td>.3</td>
<td>5.7</td>
<td>82.7</td>
<td>xx</td>
</tr>
<tr>
<td>Posttest</td>
<td>77</td>
<td>64.1</td>
<td>65.0</td>
<td>14.2</td>
<td>-.7</td>
<td>21.3</td>
<td>92.1</td>
<td>31.6</td>
</tr>
<tr>
<td>Agricultural Science</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pretest</td>
<td>66</td>
<td>43.8</td>
<td>43.6</td>
<td>12.6</td>
<td>.3</td>
<td>8.6</td>
<td>75.1</td>
<td>xx</td>
</tr>
<tr>
<td>Posttest</td>
<td>66</td>
<td>66.2</td>
<td>69.9</td>
<td>18.4</td>
<td>-.6</td>
<td>18.6</td>
<td>94.3</td>
<td>22.5</td>
</tr>
</tbody>
</table>

Note: Knowledge percent correct values reflect the percentage of items answered correctly on a 61 item knowledge test
Figure 5: Box and Wiskers Plot to Identify Pretest Outliers*

Figure 6: Box and Wiskers Plot to Identify Posttest Outliers*

(* Details regarding Box and Wisker lots are described in Hinkle, Wieserman and Jurs, 1988)
Pretest Knowledge Differences

Mean pretest scores indicate that the secondary science students had a score of eleven percentage points below the mean score of the agricultural science students (see Table 4). A t-test was computed to compare the mean percentage of correct scores of the secondary science and agricultural science students. The purpose of the test was to determine the probability that the difference reflects a true difference between the groups of subjects rather than chance variations/differences in the data. Levene’s test for testing the equal variance assumption revealed the assumption of equal variance was met. The t-test for equal variances was calculated and revealed significant differences in the group test score means (t=5.89, p<.001). Therefore, it was concluded that a significant difference existed in the pretest knowledge scores between the secondary science students (M = 32.7%, SD = 15.2%) and agricultural science students (M = 43.8%, SD = 12.6%).

Posttest Knowledge Differences

Mean posttest scores between the two groups of students (Table 5) were not significantly different. The Levene’s test for equal variance revealed that the assumption of equal variance was not met (p<.05) for posttest scores. Thus, using the independent t-test formula for unequal variances the analysis revealed the posttest scores for secondary science and agricultural science students were not significantly different (t=.8 p =.48). Mean posttest scores were 64.14% (SD = 14.2%) and 66.27% (SD = 18.4%) for the secondary science and agricultural science students, respectively.
Table 5. Summary of Independent t-test Results.

<table>
<thead>
<tr>
<th>Test by Group</th>
<th>N</th>
<th>Mean</th>
<th>S.D.</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agricultural Science</td>
<td>66</td>
<td>43.6</td>
<td>12.6</td>
<td>5.9</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Secondary Science</td>
<td>77</td>
<td>31.4</td>
<td>15.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Posttest</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agricultural Science</td>
<td>66</td>
<td>66.2</td>
<td>18.4</td>
<td>0.8</td>
<td>0.480</td>
</tr>
<tr>
<td>Secondary Science</td>
<td>77</td>
<td>64.1</td>
<td>14.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gain/ Change Values</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agricultural Science</td>
<td>66</td>
<td>22.5</td>
<td>20.5</td>
<td>2.6</td>
<td>0.001</td>
</tr>
<tr>
<td>Secondary Science</td>
<td>77</td>
<td>31.6</td>
<td>21.1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Changes in Knowledge

When compared to the pretest scores, the posttest IPM knowledge scores show an average increase of approximately 32% and 23%, respectively (Table 5), for the secondary science and agricultural science students. The mean percent of change in posttest scores was significantly higher for the secondary science students than for the agricultural science students (t=2.6, p=.001). The mean percent of change, which is often referred to as gain scores, was calculated by examining differences in pretest and posttest IPM knowledge scores. The paired t-test results in Table 6 reveal that the gain scores were statistically significant for both the secondary science and agricultural science students.
Table 6. Summary of Paired t-test Results.

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Pretest %</th>
<th>S.D. %</th>
<th>Posttest %</th>
<th>S.D. %</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural Science</td>
<td>66</td>
<td>43.6</td>
<td>12.6</td>
<td>66.2</td>
<td>18.4</td>
<td>13.9</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Secondary Science</td>
<td>77</td>
<td>31.4</td>
<td>15.2</td>
<td>64.1</td>
<td>14.2</td>
<td>19.6</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

Student Attitudes

Table 7 shows the pre- and post-responses of secondary science and agricultural science students to 29 attitudinal questions/statements regarding IPM and related issues. To determine changes in students’ attitudes regarding IPM, students were asked to complete the attitude instrument by responding on a 5-point, Likert-type scale to 29 questions and statements. The response scale was from 1 to 5, with a response of 1 indicating that the student strongly disagreed with the statement/question, 2 = disagreed, 3 = the student had did not know or have an opinion, 4 = agreed, and 5 = strongly agreed. The mean, standard deviation and changes between pre-attitude and post-attitude mean values are also reported.

Questions/statements with a negative numerical value, in all but six cases, indicate a more positive change in perception towards IPM practices. A commonly used benchmark to determine significant changes in attitude is an increase or decrease of ten percent of the total response scale. Therefore, a difference of one-half point on the instrument’s five-point scale would be considered substantively significant (E. P. Yoder, personal communication).
### Table 7. Student Responses to IPM Attitude Questionnaire Questions/Statements

<table>
<thead>
<tr>
<th>Attitude question/statement</th>
<th>Prior to instruction</th>
<th>After receiving instruction</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Don't Know</td>
</tr>
<tr>
<td>1. Practicing IPM means that pesticides are not used.</td>
<td>Sci. 14.8</td>
<td>22.2</td>
<td>42.6</td>
</tr>
<tr>
<td></td>
<td>Ag. 21.6</td>
<td>39.8</td>
<td>22.7</td>
</tr>
<tr>
<td>2. IPM is a process of controlling pests by controlling the environment where they may live.</td>
<td>Sci. 4.6</td>
<td>5.6</td>
<td>30.6</td>
</tr>
<tr>
<td></td>
<td>Ag. 2.3</td>
<td>5.7</td>
<td>15.9</td>
</tr>
<tr>
<td>3. Practicing IPM is something only farmers do to produce crops.</td>
<td>Sci. 30.6</td>
<td>38.9</td>
<td>23.1</td>
</tr>
<tr>
<td></td>
<td>Ag. 30.7</td>
<td>55.7</td>
<td>6.8</td>
</tr>
<tr>
<td>4. IPM is a new concept that was just introduced a couple of years ago.</td>
<td>Sci. 8.4</td>
<td>25.2</td>
<td>54.2</td>
</tr>
<tr>
<td></td>
<td>Ag. 11.4</td>
<td>25.0</td>
<td>38.6</td>
</tr>
<tr>
<td>5. One pesticide is as poisonous as another.</td>
<td>Sci. 9.3</td>
<td>32.7</td>
<td>21.5</td>
</tr>
<tr>
<td></td>
<td>Ag. 14.8</td>
<td>45.5</td>
<td>17.0</td>
</tr>
<tr>
<td>6. For IPM to be considered a success all pests must be completely eliminated.</td>
<td>Sci. 13.0</td>
<td>39.8</td>
<td>25.9</td>
</tr>
<tr>
<td></td>
<td>Ag. 18.2</td>
<td>45.5</td>
<td>17.0</td>
</tr>
<tr>
<td>7. All insects are pests that cause damage.</td>
<td>Sci. 37.4</td>
<td>34.6</td>
<td>10.3</td>
</tr>
<tr>
<td></td>
<td>Ag. 34.1</td>
<td>40.9</td>
<td>6.9</td>
</tr>
<tr>
<td>Attitude question/statement</td>
<td>Prior to instruction</td>
<td>After receiving instruction</td>
<td>Change</td>
</tr>
<tr>
<td>------------------------------------------------------------------------------------------</td>
<td>----------------------</td>
<td>-----------------------------</td>
<td>--------</td>
</tr>
<tr>
<td>8. The more poisonous the pesticide the more effective it is.</td>
<td>Sci. 21.5 34.6 13.4 22.2 8.3 2.6 ± 1.3</td>
<td>Sci. 36.1 44.4 2.80 15.3 1.40 2.1 ± 1.1</td>
<td>-0.5</td>
</tr>
<tr>
<td></td>
<td>Ag. 23.9 35.2 11.4 26.1 3.4 2.5 ± 1.2</td>
<td>Ag. 24.0 43.0 8.0 17.0 8.0 2.4 ± 1.3</td>
<td>-0.1</td>
</tr>
<tr>
<td>9. IPM is only about controlling insects.</td>
<td>Sci. 17.0 36.8 30.2 13.2 2.8 2.5 ± 1.0</td>
<td>Sci. 30.1 41.1 8.20 15.1 5.50 2.2 ± 1.2</td>
<td>-0.3</td>
</tr>
<tr>
<td></td>
<td>Ag. 6.9 56.9 21.3 13.7 1.2 2.9 ± 4.4</td>
<td>Ag. 31.3 39.4 12.1 15.2 2.0 2.2 ± 1.1</td>
<td>-0.7</td>
</tr>
<tr>
<td>10. Pests can be managed in a way that is compatible with nature.</td>
<td>Sci. 1.9 5.5 24.1 48.1 20.4 3.8 ± .9</td>
<td>Sci. 1.4 6.8 5.5 52.1 34.2 4.1 ± .9</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td>Ag. 1.3 9.4 11.9 59.2 18.2 3.9 ± .87</td>
<td>Ag. 3.0 7.0 8.0 57.0 25.0 3.9 ± .9</td>
<td>0.0</td>
</tr>
<tr>
<td>11. Pest management is only necessary when you see pests present.</td>
<td>Sci. 18.9 40.6 21.6 14.2 4.7 2.5 ± 1.1</td>
<td>Sci. 16.7 52.8 5.6 20.7 4.2 2.4 ± 1.1</td>
<td>-0.1</td>
</tr>
<tr>
<td></td>
<td>Ag. 10.2 61.4 9.1 18.2 1.1 2.4 ± .9</td>
<td>Ag. 14.0 42.0 11.0 27.0 6.0 2.7 ± 1.2</td>
<td>0.3</td>
</tr>
<tr>
<td>12. Weeds are as much a pest as insects.</td>
<td>Sci. 4.7 4.6 15.0 53.3 22.4 3.8 ± 1.0</td>
<td>Sci. 1.4 6.9 2.8 58.3 30.6 4.1 ± .9</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td>Ag. 1.2 9.2 9.2 56.3 24.1 3.9 ± .9</td>
<td>Ag. 3.0 9.0 10.0 49.0 29.0 3.9 ± 1.0</td>
<td>0.0</td>
</tr>
<tr>
<td>13. Rat poison is always better than a trap.</td>
<td>Sci. 25.2 37.8 11.7 17.5 7.8 2.4 ± 1.3</td>
<td>Sci. 33.8 49.6 9.8 5.4 1.4 1.9 ± .9</td>
<td>-0.5</td>
</tr>
<tr>
<td></td>
<td>Ag. 11.8 61.2 14.1 9.4 3.5 2.3 ± .9</td>
<td>Ag. 23.2 52.5 11.1 7.1 6.1 2.2 ± 1.1</td>
<td>-0.1</td>
</tr>
<tr>
<td>14. Using an increased amount of a pesticide usually helps to get rid of the pest faster.</td>
<td>Sci. 18.4 31.1 26.2 21.4 2.9 2.6 ± 1.1</td>
<td>Sci. 26.4 47.4 17.8 7.0 1.4 2.1 ± .9</td>
<td>-0.5</td>
</tr>
<tr>
<td></td>
<td>Ag. 12.5 51.1 12.5 20.5 3.4 2.3 ± .92</td>
<td>Ag. 25.3 46.5 12.1 15.1 1.0 2.2 ± 1.0</td>
<td>-0.1</td>
</tr>
<tr>
<td>15. Fixing cracks in windows and repairing screens is a good way to control pests.</td>
<td>Sci. 1.0 8.8 23.6 52.9 14 3.7 ± .9</td>
<td>Sci. 1.4 1.5 4.3 51.4 41.4 4.3 ± .7</td>
<td>0.6</td>
</tr>
<tr>
<td></td>
<td>Ag. 3.4 6.8 8.0 62.5 19.3 3.9 ± .75</td>
<td>Ag. 4.0 8.9 3.0 53.5 30.6 4.1 ± .8</td>
<td>0.2</td>
</tr>
</tbody>
</table>
Table 7. Continued.

<table>
<thead>
<tr>
<th>Attitude question/statement</th>
<th>Prior to instruction</th>
<th>After receiving instruction</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SD</td>
<td>D</td>
<td>DK</td>
</tr>
<tr>
<td>16. All insect sprays kill the same insects.</td>
<td>Sci.</td>
<td>32.0</td>
<td>47.6</td>
</tr>
<tr>
<td></td>
<td>Ag.</td>
<td>23.5</td>
<td>61.2</td>
</tr>
<tr>
<td>17. Keeping your room clean and not leaving food and food wrappers around helps control pests.</td>
<td>Sci.</td>
<td>7.8</td>
<td>8.7</td>
</tr>
<tr>
<td></td>
<td>Ag.</td>
<td>1.2</td>
<td>10.5</td>
</tr>
<tr>
<td>18. Pesticides only kill the pests you are trying to kill.</td>
<td>Sci.</td>
<td>22.7</td>
<td>42.6</td>
</tr>
<tr>
<td></td>
<td>Ag.</td>
<td>25.0</td>
<td>51.1</td>
</tr>
<tr>
<td>19. Pesticides are not used to kill things like mold, fungus, or bacteria in swimming pools.</td>
<td>Sci.</td>
<td>9.8</td>
<td>23.5</td>
</tr>
<tr>
<td></td>
<td>Ag.</td>
<td>9.2</td>
<td>35.3</td>
</tr>
<tr>
<td>20. If there are no pesticide residues on foods, that means no pesticides were used in production.</td>
<td>Sci.</td>
<td>11.9</td>
<td>44.6</td>
</tr>
<tr>
<td></td>
<td>Ag.</td>
<td>7.1</td>
<td>48.2</td>
</tr>
<tr>
<td>21. We don't use pesticides in or around our home.</td>
<td>Sci.</td>
<td>16.8</td>
<td>38.6</td>
</tr>
<tr>
<td></td>
<td>Ag.</td>
<td>14.1</td>
<td>48.2</td>
</tr>
<tr>
<td>22. There are not many choices other than pesticides to control pests.</td>
<td>Sci.</td>
<td>17.6</td>
<td>33.3</td>
</tr>
<tr>
<td></td>
<td>Ag.</td>
<td>14.2</td>
<td>46.6</td>
</tr>
<tr>
<td>23. Pesticides can be used as part of an IPM program, but only as a last resort.</td>
<td>Sci.</td>
<td>9.8</td>
<td>17.6</td>
</tr>
<tr>
<td></td>
<td>Ag.</td>
<td>2.4</td>
<td>25.8</td>
</tr>
</tbody>
</table>
Table 7. Continued.

<table>
<thead>
<tr>
<th>Attitude question/statement</th>
<th>Prior to instruction</th>
<th>After receiving instruction</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SD</td>
<td>D</td>
<td>DK</td>
</tr>
<tr>
<td><strong>24. It is not important to identify an insect you are trying to control.</strong></td>
<td>Sci.</td>
<td>22.5</td>
<td>34.3</td>
</tr>
<tr>
<td></td>
<td>Ag.</td>
<td>17.8</td>
<td>51.2</td>
</tr>
<tr>
<td><strong>25. Monitoring to determine how many pests are present is not important because if they are present pests must be controlled.</strong></td>
<td>Sci.</td>
<td>11.9</td>
<td>33.7</td>
</tr>
<tr>
<td></td>
<td>Ag.</td>
<td>10.7</td>
<td>47.6</td>
</tr>
<tr>
<td><strong>26. Keeping a record of past pest problems will help with future pest control.</strong></td>
<td>Sci.</td>
<td>2.9</td>
<td>10.8</td>
</tr>
<tr>
<td></td>
<td>Ag.</td>
<td>3.4</td>
<td>5.7</td>
</tr>
<tr>
<td><strong>27. Pesticides with a lower toxicity are available that will control the same pest as pesticides with a higher toxicity.</strong></td>
<td>Sci.</td>
<td>5.9</td>
<td>17.6</td>
</tr>
<tr>
<td></td>
<td>Ag.</td>
<td>3.6</td>
<td>21.4</td>
</tr>
<tr>
<td><strong>28. There is very little information available to help homeowners develop an IPM plan.</strong></td>
<td>Sci.</td>
<td>16.5</td>
<td>23.3</td>
</tr>
<tr>
<td></td>
<td>Ag.</td>
<td>15.3</td>
<td>42.4</td>
</tr>
<tr>
<td><strong>29. There are very few opportunities to practice IPM around the home.</strong></td>
<td>Sci.</td>
<td>15.5</td>
<td>28.2</td>
</tr>
<tr>
<td></td>
<td>Ag.</td>
<td>7.1</td>
<td>48.2</td>
</tr>
</tbody>
</table>
In accepting this benchmark the researcher established that a one-half point change in the mean response to a question/ statement on the attitude instrument indicated a practical change in student attitude for the item.

The secondary science students showed the most significant changes in response to the attitude questions/ statements. Secondary science students showed significant changes in the attitude in response to 11 of 29 statements/ questions (Figure 7). In these 11 statements there was a difference of one-half point or more between the mean of the pre attitude instrument response and the mean of the post attitude instrument response to a specific question/ statement. The most significant change, .8 points, was in response to the practice of including pesticides as part of an IPM plan. The second highest change, .7 points, indicated that students realized that keeping their room clean and not leaving food around was an effective IPM practice. This level of change was also reported to show that students understood that IPM is not only about controlling insects. The most significant changes in attitudes were in response to the concepts most critical to the success of IPM. For example, the majority of the most significant changes in attitudes, a .6 change from pretest to posttest, were in response to the statements regarding the amount of information and number of opportunities available relative to IPM. A .6 change in attitude was also indicated in response to the statement about fixing cracks and repairing screens and using pesticides in the student's home environment. Another significant change, .5 points, indicated that students also understood that higher rates and more poisonous chemicals did not mean more effective pest control.
Figure 7. Secondary Science Students’ Responses to Attitude Instrument Questions/Statements which Showed Significant Changes in Attitude. (Complete text and of the statements and attitude questionnaire can be found in Table 7, on pages 52 - 55).
Agricultural science students showed significant changes in response to three of the IPM attitude question/statements (see Figure 8). The most significant change in the agricultural science students’ attitude, a .7 change, was in regards to the statement, “IPM is only about controlling insects.” The agricultural science students showed a .5 change in attitude in response to the statement regarding the opportunities available to practice IPM and the concept that one pesticide is not as poisonous as another.

**External Summative Evaluations**

Two types of external summative evaluations were conducted. One external summative evaluation was completed using an Environmental Education Curriculum Evaluation Instrument, developed by Daphne Minner, research associate at The Pennsylvania State University (Minner, 1998). A second external summative evaluation was conducted using a checklist evaluation form adapted from Zenger and Zenger’s curriculum guide development checklist (Zenger & Zenger, 1982).

Minner’s instrument assesses curriculum quality by asking a series of specific, concrete questions about the lessons in the curriculum being reviewed. Minner, who used her instrument to evaluate 35 curricula, completed an evaluation of the IPM instructional unit. The instrument was completed based on the evaluation of lessons two, four, five, eight and nine. In the final analysis, the IPM instructional unit scored 108 points. Scores between 95 points and 115 points are considered medium quality score.
Curricula that score above 116 points are considered high quality. Of the four areas, the IPM instructional unit scored highest in context, followed by developmental appropriateness, structure and content respectively. A review of the completed evaluation pointed out several areas for curriculum enhancement.

The scores on Minner’s instrument, which is designed to assess the quality of environmental scores, would most likely have been higher if all of the lessons had been evaluated. For example, question number 16 asks, “In which historical context are environment problems discussed?” A value of one (on a scale of one to three, with one being the lowest) was assigned to this criterion. However, if lesson one, which presented a great deal of historical
perspective relative to IPM, had been included in the evaluation, the value would most likely have been much higher. All of the remaining areas that scored lowest will be addressed in the recommendations and suggestions for future research.

The instructors who participated in the research completed the evaluation adapted from Zenger and Zenger (see Appendix H). In addition, this evaluation was completed by a member of the Pennsylvania IPM staff who was a former secondary school science teacher, and a member of the Pesticide Education office who was a former secondary agricultural science instructor. This evaluation addressed 25 elements of the curriculum that were broken down into the following seven areas: Background, Organization, Content, Objectives, Materials and Resources, Instructional Procedures and Activities and Evaluation. Although there were some suggestions for improvement, the evaluators felt that 17 of the 25 areas were either acceptable as they appeared or did not apply to the curriculum. The three most frequent areas noted for improvement were the addition of a table of contents and suggestions for appropriate instructional materials and where to locate and order the instructional material. Three of the seven evaluators felt that the curriculum needs to be improved to allow for differing levels of ability or cultural backgrounds. The section regarding evaluation received the most diverse comments. The majority of the evaluators felt that all items in this section were either acceptable as they appeared or more commonly agreed that the questions did not apply. One evaluator did feel that improvement was needed in the description of the testing and grading policies and how testing and grading are developed from goals and objectives. However, one evaluator
rather adamantly noted that, "I would be insulted if the curriculum told me how to grade my students' performance." All of the evaluators indicated that they would use the curriculum in their classroom instruction, and that students would find it interesting. In response to the inquiry regarding the appropriate grade level for this instruction, all instructors felt that it was appropriate for grades ten through twelve. Two instructors felt it would be appropriate as low as grade eight. One evaluator commented that the curriculum would also be appropriate for adult education.

Summary

Statistical analyses of the pretest and posttest data indicate a significant increase in knowledge for both the secondary science and agricultural science students. Analysis of the data collected regarding students' attitudes relative to IPM concepts indicates a more significant change in attitude for the secondary science students. However, both the secondary science and agricultural science students had significant changes in attitude relative to the fact that IPM is not a new concept, and that there are many opportunities to practice IPM. The data collected from participating students indicate student mastery of the concept that there are many alternatives, non-chemical and chemical, that play a role in an IPM program. All of the summative evaluations were positive and indicated the evaluators felt the instructional unit would be used as part of a curriculum and that students would find it interesting to study. The collection and analysis of the data and summative evaluations allowed the researcher to meet Posner and Rudnitsky's (1994) ideal of determining to what extent the objectives are being achieved through
the selected content and method. It also allows for, as Posner and Rudnitsky (1994) suggest, gathering information to evaluate the course which will help determine which aspects can and should be improved.
Chapter 5

CONCLUSIONS, COMMENTS AND RECOMMENDATIONS FOR FUTURE RESEARCH

Curriculum development is a never-ending process. Curriculum development is not finished when a single curricular problem has been temporarily solved or a newer, revised program has been instituted. (Taba, 1962, p. 458)

Although spoken almost 40 years ago, these words of Hilda Taba are not only still extremely profound, but also critical to the developmental success of any curricular materials. All too often materials are created and revision is left to the instructor who may or may not have access to resources as they become available. In her thesis, “Current Practices in Agricultural Curriculum Development,” Brown (1997) concluded that the lack of regularly scheduled curriculum revision indicated that resources and references should be available at all times for use by agriculture teachers. These references should be easy to obtain and use. Brown’s conclusion, which is supported by Pucel (1990), also shows that from the perspective of both agricultural science instructors and curriculum supervisors that local, state or federal statutory changes almost “always” initiate curriculum change. Such is the case with the inclusion of the IPM requirement into the Pennsylvania educational standards for Environment and Ecology. As a result, it is imperative that an IPM curriculum and supporting resource materials be available.

Following Posner & Rudnitsky’s (1994) suggestion, it was the researcher’s intention to conduct evaluations to determine if the objectives of the IPM unit of instruction were achieved through the selected content and instructional method. In addition, summative evaluations were conducted for
the purpose of soliciting outside input to determine which components of the
unit should be enhanced. As a result of the data analysis and collection of
summative evaluations, the following conclusions were drawn and
recommendations for enhancement made.

Conclusions Regarding Student Knowledge

Low pretest scores, 32.7 percent items correct for secondary science
students and 43.8 percent for agricultural science students, and PDE survey
data that indicate IPM is the second least frequently taught subject matter of
those included in the proposed Environment and Ecology standards illustrate
the need for IPM related instruction. Although the overall mean scores from
the posttest were somewhat lower than the researcher initially desired, 64.1
percent correct for the secondary science students and 66.2 percent for the
agricultural science students, the increases in knowledge are statistically and
substantively significant. Averages of a 31.6 percent increase for the secondary
science students and a 22.5 percent increase in agricultural science students’
posttest scores indicate the overall improvement in student knowledge and
thus indirectly the effectiveness of the IPM curriculum. Careful review of the
scores for individual knowledge test items of the posttest score reveals
potential areas for curriculum enhancement and improvement of individual
test items.

Table 8 shows 13 test items for which less than 50 percent of the
students answered the item correctly. Because less than one-half of the
students selected the correct answer to the test item, the researcher concludes
that the related instructional areas may need to be strengthened. Test item
number 36,
Table 8. Posttest Questions to Which a High Percentage of Students’ Post-Instruction Responded Incorrectly.

<table>
<thead>
<tr>
<th>Test Item Concept</th>
<th>Pretest Percentage Correct</th>
<th>Posttest Percentage Correct</th>
<th>Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>What type of pest control is a Japanese beetle trap?</td>
<td>12.6</td>
<td>24.5</td>
<td>11.9</td>
</tr>
<tr>
<td>What type of pest control is the use of resistant plants?</td>
<td>23.8</td>
<td>39.9</td>
<td>16.1</td>
</tr>
<tr>
<td>Which factor is not important to an IPM strategy?</td>
<td>26.6</td>
<td>49.0</td>
<td>22.4</td>
</tr>
<tr>
<td>Which term refers to birth defects?</td>
<td>11.9</td>
<td>30.1</td>
<td>18.2</td>
</tr>
<tr>
<td>Which signal word indicates potential skin and eye irritant?</td>
<td>7.7</td>
<td>34.3</td>
<td>26.6</td>
</tr>
<tr>
<td>Classification of pesticides.</td>
<td>24.5</td>
<td>49.7</td>
<td>25.2</td>
</tr>
<tr>
<td>Which is not relative to pest management strategies?</td>
<td>26.6</td>
<td>48.3</td>
<td>21.7</td>
</tr>
<tr>
<td>EPA identification of pesticide products.</td>
<td>26.6</td>
<td>42.7</td>
<td>16.1</td>
</tr>
<tr>
<td>When are chemical controls justified?</td>
<td>16.1</td>
<td>37.1</td>
<td>21.0</td>
</tr>
<tr>
<td>How should containers be handled for disposal?</td>
<td>37.8</td>
<td>49.9</td>
<td>12.1</td>
</tr>
<tr>
<td>Which pesticides causes fish kills.</td>
<td>24.5</td>
<td>25.2</td>
<td>.7</td>
</tr>
<tr>
<td>How pesticides reach ground water.</td>
<td>16.8</td>
<td>35.0</td>
<td>18.2</td>
</tr>
<tr>
<td>Identify results of animal laboratory testing.</td>
<td>23.8</td>
<td>45.5</td>
<td>21.7</td>
</tr>
</tbody>
</table>
“Which class of pesticides is most commonly associated with fish kills”, is obviously in need of revision. With only four choices to select, statistically the correct answer should have been selected at least 25 percent of the time. However, data analysis indicates that on the pretest the correct answer was selected only 24.5 percent of the time. With less than a 1 percent increase in the correct response rate from the pretest to posttest, the correct response rate was barely over the statistical probability selection rate.

Conclusions Regarding Student Attitude

The data show a significant change in secondary science students’ attitudes relative to 11 of the 29 IPM attitude questions/statements. However, review of posttest instrument responses (see Table 9) reveals several areas where 25 percent or more of the students answered “don’t know” to the question/statement. In other cases, the percentage of those who responded “don’t know” was as high as 44.7 percent. For example, even though both groups showed a significant change--.5 points in attitude when responding to the statement, IPM is a new concept that was just introduced a couple of years ago, over 40 percent responded “don’t know” to that statement. Over 40 percent of the students responding had the same response to the statement that pesticides are included in IPM decision-making but “only as a last resort.” The high rate of “don’t know” responses indicates to the researcher that these are areas of the instructional unit that should be enhanced with additional information or student learning activities.
Table 9. Attitude Questions/Statements to which a High Percentage of Students’ Post-Instruction Response was “Don’t Know.”

<table>
<thead>
<tr>
<th>IPM Attitude Question/Statement</th>
<th>Pre-Group Response</th>
<th>Post-Response Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. IPM is a new concept that was just introduced a couple of years ago</td>
<td>Sci. 54.2</td>
<td>23.3-30.9</td>
</tr>
<tr>
<td></td>
<td>Ag. 38.6</td>
<td>16.8-21.8</td>
</tr>
<tr>
<td>14. Using an increased amount of a pesticide usually helps to get rid of the pest faster</td>
<td>Sci. 26.2</td>
<td>17.8-8.4</td>
</tr>
<tr>
<td></td>
<td>Ag. 12.5</td>
<td>12.1-0.4</td>
</tr>
<tr>
<td>20. If there are no pesticide residues on foods, that means that no pesticides were used in production.</td>
<td>Sci. 32.7</td>
<td>11.3-21.4</td>
</tr>
<tr>
<td></td>
<td>Ag. 32.9</td>
<td>17.2-15.7</td>
</tr>
<tr>
<td>21. We don't use pesticides in or around our home.</td>
<td>Sci. 22.8</td>
<td>12.2-10.6</td>
</tr>
<tr>
<td></td>
<td>Ag. 15.4</td>
<td>13.1-2.3</td>
</tr>
<tr>
<td>23. Pesticides can be used as part of an IPM program, but only as a last resort.</td>
<td>Sci. 45.1</td>
<td>24.3-20.8</td>
</tr>
<tr>
<td></td>
<td>Ag. 31.8</td>
<td>18.2-13.6</td>
</tr>
<tr>
<td>27. Pesticides with a lower toxicity are available that will control the same pest as pesticides with a higher toxicity.</td>
<td>Sci. 47.1</td>
<td>23.9-23.2</td>
</tr>
<tr>
<td></td>
<td>Ag. 34.5</td>
<td>20.8-13.7</td>
</tr>
</tbody>
</table>
Recommendations from Instructors and Independent External Summative Evaluations

The qualitative evaluations of the instructors and the additional external summative evaluations were similar in several areas. The majority of the instructors who participated in the research indicated that overheads that outline and illustrate the major points of the lessons and an instructor key for the student guide would have been the most helpful enhancement. Evaluators also requested the inclusion of a guide for ordering resource materials. Several recommended the addition of more hands-on activities. Many suggestions were format issues that when corrected would make the lessons clearer and resources easier to identify, and would improve minor inconsistencies. For example, the addition of a table of contents would help to more easily identify the concepts included in each lesson. Two evaluators mentioned that the unit could be strengthened by including more pest identification information or incorporating the unit along with a unit on typical pests and classification of insects, weed, rodent and common pests.

Researcher’s Conclusions Regarding Curriculum Development

After completing the study it can be concluded that several changes in methodology would have increased both the participatory nature of the study and the data available to enhance the unit. These include:

1. Different methodology to select sample to allow for a larger population from which the sample may be selected.
2. Additional input from other instructors and content experts for the improvement of the curriculum.
3. A minimum one-day inservice training session for teachers to review the lessons and demonstrate the activities and visuals. The inservice training should be conducted separate from the distractions of the classroom.

4. More formative evaluations by teachers and students to gain greater quantitative and qualitative insights. In retrospect, evaluating students to determine their increases in knowledge and perspectives on a more routine basis throughout the unit would likely provide data for more specific improvements to the unit of instruction. For example, students could be queried regarding the interest level of the lessons, visuals, and other associated materials. In addition, students could offer more immediate input regarding suggestions for improvement of the lessons.

5. Follow up evaluation four months after completion of the unit of instruction to determine knowledge retention and attitude changes.

In addition, the availability of a grant from PDA allowed for the opportunity to provide the instructors and students with adequate resource materials. As a former agricultural science instructor, I realize the constraints these instructors face and I value their time and commitment to this research. Therefore, a modest honorarium was provided to the instructors for their facilitation of this study in their classes. It is the opinion of the researcher that the procurement of sufficient funding to provide these resources and modest financial compensation should be a goal of curriculum developers.
Opportunities in the Future

As part of the Penn State Cooperative Extension Annual Conference, held in November 1999, Penn State IPM coordinator Dr. Ed Rajotte, and IPM education specialist Lyn Garling conducted a concurrent session titled, “Teaching IPM to Pennsylvania’s Youth.” The description of the inservice indicated that “all K-12 students in Pennsylvania will be learning about Integrated Pest Management as a part of newly adopted state academic standards.” The session description offered the opportunity to “Learn about this program and what you can do with your local school systems” (Cooperative Extension Annual Conference flyer, 1999). The overall message presented during the program implied that IPM education would present extension agents with a potential new clientele and an opportunity to work with the school systems. In an effort to be more responsive to the extension agents needs, Dr. Rajotte included a needs assessment as part of the inservice program. Several of the extension agents present indicated that they were already receiving requests for educational materials (Researcher participation in the inservice). When informed about the impending availability of the materials developed through this research, several of the agents made the request that a copy of the instructional materials be sent to each of the county extension offices.

Copies of the instructional materials developed and evaluated during this research have also been requested by Conservation Districts and instructors in the College of Education who prepare future science teachers. The opportunity also exists to establish distribution networks through science and environmental science teacher education networks. At the national level,
the researcher was provided the opportunity to deliver a professional development workshop at the 1999 National Association of Agricultural Educators (NAAE) national conference in Orlando, Florida. The researcher has also been requested to serve on an advisory committee for an EPA-funded IPM curriculum development project which will be coordinated through the Penn State IPM program (Rajotte & Garling, 1999).

**Future Research**

The inclusion of IPM education in the proposed state educational standards for environment and ecology provides new opportunities for future research in the curriculum area.

1. The environmental and ecology standards are K-12 inclusive. Therefore, development and evaluation of K-8 instructional units is an area where future research will be necessary.

2. The IPM curriculum development project funded by the EPA, which is being coordinated through the Pennsylvania State University IPM program, provides the opportunity for research in interdisciplinary cooperative IPM education.

3. Review of the needs assessments completed by extension personnel who attended the “Teaching IPM to Pennsylvania’s Youth” inservice will most likely provide insights for additional research in this area.

4. With the increase in the number of home-schooled students, research could be conducted to determine the effectiveness of the IPM unit of instruction as a course for independent study.
5. A web-based independent study module could be developed to facilitate outreach education for secondary students and adults.

Summary

The inclusion of an IPM educational unit that is balanced in its perceptions into the already existing secondary science and agricultural science curricula can serve several purposes. The unit will fill the need to provide instruction so that students will be prepared to meet the state standards and score well on PSSA exams. However, more importantly, mastery of the concepts in the IPM unit of instructions will help to prepare students to be more informed consumers, more environmentally aware of alternatives for pest control, and safer applicators if and when the need to use pesticides arises. As Van Crowder noted, is also critical to remember: “curriculum is not a fixed product but a dynamic process--it is an ongoing process that responds to changes in society” (Van Crowder, 1997, p. 2)


Appendix A
Integrated Pest Management
Unit of Instruction
In 1962 Rachael Carson’s book, *Silent Spring*, brought the issue of pesticide use to the forefront of consumer and environmentalists concerns. In 1989 the use of Alar® on apples once again brought the issue of pesticide use back into the spotlight. Alar®, growth regulator which helped to synchronize when apples dropped from the tree, is regulated by state and national agencies in the same way as a pesticide. In the case of Alar®, the concern focused on the use of pesticides on food crops, and the pesticide residue that remains on the food. As a result of continued media coverage, and pressure from public interest groups, the issue of pesticide residues in foods remains a concern.

Proper education of today’s youth will help them make educated decisions regarding pest control, alternatives to pesticide use, safe use of pesticides when necessary, and other related factors. This education is imperative, not only to protect human health and safety, but also to preserve the environment.

In regard to pest management, it is no longer enough to educate only the pesticide applicator whose livelihood depends in part on the safe use of pesticides. It is also important for two basic reasons to educate the consumer. Primarily, this education will allow homeowners to gain an understanding of the principles related to alternatives to pesticide use around the home, and safe application and handling when the use of pesticides is necessary. Just as important, education of this type will allow consumers to become more informed and give them the ability to make decisions based on education, rather than emotion. The integration of a pest management unit into already existing curriculum can serve as a solid foundation for this education.

The purpose of this unit is to provide instructors with a guideline and a knowledge base to facilitate the integration of this material into existing curricula. The ultimate goal is to provide instructors with an educational base to take with and “run with”, personalizing it to fit the needs and constraints of each individual class.

Perhaps William Reily, former EPA administrator said it best:

“In the end, environmental education boils down to a simple and yet profoundly important imperative: preparing ourselves for life and all its surprises in the next century. When the 21st century rolls around, it will not be enough for a few specialists to know what is going on while the rest of us wander around in ignorance.”
LESSON ONE
MODERN PEST MANAGEMENT
THE HISTORY OF PEST MANAGEMENT

Learning Objectives:

Students will be able to:

1. List the common classes of pests.
2. Define the category of pesticides used to manage each class of pest.
3. Identify the major events in the history of pest management.
4. Define the concept of Integrated Pest Management (IPM).
5. List the basic components of an IPM program.
6. List the basic classes of pests and the pesticides that may be used to manage each class.

Materials:

1. Penn State Pesticide Education Manual
2. Citizen’s Guide to Pest Control
3. Student Lecture Guide

Procedures for Evaluation:

1. Student guide evaluation

Session Outline

I. Lecture: Unit Objectives, Pesticide History

II. Lecture: Introduction to Integrated Pest Management and the components of IPM.
Lecture Points: The History of Pests and Pesticides

- **Definition of pest:**
  
  - A **pest** is, “an organism (weed, insect, fungus, disease organism, etc.) which causes injury to humans, desirable plants, or animals”

- Pests have been a problem in society since the beginning of time.

- Some pests have had a major impact in history.

- One example was the Black Plague of Europe in the fourteenth century. This was a bacterial infection that spread to humans from rat fleas. The fleas became infected with the bacteria while feeding on diseased rats. Today the disease is known as bubonic plague. The disease is not very common anymore because it is controlled by reducing populations of rats and fleas.

- One historical pest problem had a direct influence on the population of the United States. In the nineteenth century, in Ireland, a fungus disease called late blight basically eliminated the entire potato crop, which was the country’s major food source. Because of the famine many people starved and over one million people came to the United States in search of a better life. Today this disease is still a problem. However, the combination of using plants that are resistant to the disease and chemical pesticides, it is being controlled.

- **Definition of a pesticide:**
  
  - A **pesticide** is defined as a chemical used to kill, control, or prevent the development of pests. Pesticides are also used to protect plants, animals, or humans from pests.

- When the first crops were planted, pest management soon followed.

- Rather than control pests early agriculture assumed and took into consideration that there would be pest damage when deciding the type and number of crops to plant.
History of pest management-

- **2500 B.C.** - The earliest use of chemicals as pesticides dates back to when sulfur was burned to control insects and mites.

- **300 B.C.** - The earliest use of Integrated Pest Management (IPM) dates back at least this far when the Chinese recognized **phenology** (the connection between climate and occasional biological events) as a science. This led to timing the planting of the crop to avoid the pest attack. At about this same time, the Chinese began using natural enemies to pests and on citrus to reduce pest problems.

- **1101 A.D.** - The Chinese discover soap as a pesticide.

- **1860’s** - Use of Paris green (a mixture of copper sulfate and arsenic) began for the control of Colorado potato beetle.

- **Late 1800’s** - Pesticide application equipment was developed.

- **Late nineteenth century** - In France, a mixture of lime and copper sulfate was sprayed on grapevines to keep people from picking the grapes. A farmer found that this mix also controlled a fungus disease called downy mildew. Later this pesticide, discovered by accident, was named Bordeaux mixture and is still one of the most widely used fungicides today.

- **1920’s - 30’s** - For the most part pesticides were ineffective, expensive and hazardous.

- **Until the 1940’s** chemicals used to control pests were made from plants or natural compounds.

- During World War II DDT was used to control insects and save soldiers from the disease that the insects carried. DDT was first discovered in 1873 by a German graduate student. Swiss scientist, Paul Muller, discovered the insecticidal properties of DDT. Because of the major impact DDT had on saving lives as a result of insect control, Muller won the **1948** Nobel prize in Medicine. DDT was promoted as the way to control all insect problems. DDT has since been banned from the market in most countries because of concerns over how long it remained in the environment, and other environmental issues.
- After the success of DDT many other man-made organic pesticides were introduced. Successful control of pests at a reasonable cost made pesticides the basic method for pest control.

- This success of pest control chemicals, particularly in agriculture, encouraged acceptance of pesticides for crop production. Synthetic pesticides and fertilizers were, and often times still are, seen as the answer to world hunger.

- Concerns over the use of pesticides first began when DDT was found in milk, and adverse effects began to show in the environment.

- When Rachel Carson wrote Silent Spring in 1962, the issue of pesticide safety was brought to the attention of the public.

**Lecture Points: Introduction to Integrated Pest Management and the components of IPM.**

- Over the past several decades the use of pesticides in agriculture has turned to a mixture of the old and the new. Nonchemical control practices such as those used by the Chinese in 300 B.C. and chemical controls have been combined to reduce the use of pesticides. The use of nonchemicals when possible, and in combination with chemical pesticides when necessary, is part of the foundation of Integrated Pest Management (IPM). IPM will be discussed in detail in the following lessons.

- Briefly the components of IPM include:

- The ability to determine if there is a problem that needs to be treated.

- The common pest problems (or classes of pests) are:

  - **Weeds**
    - Mites
    - Slugs
    - Spiders
    - Nematodes

  - **Invertebrates**
    - **Vertebrates**
      - Fungi
      - Bacteria
      - Viruses
      - Birds
- Manage options include:

  - **Non-Chemical Controls**
    - Biological Controls
    - Cultural Methods
    - Mechanical Controls
    - Physical Controls
    - Pheromones (for monitoring purposes)

- **Chemical Controls**
  - Microbial Pesticides
  - Growth Regulators
  - Synthetic Pesticides

- If you are going to use a pesticide you need to know what to use to correctly treat the pest. Common pesticides include:

  - Herbicides which are used to manage weeds.
  - Insecticides which are used to manage insects.
  - Rodenticides which are used to manage rats and other rodents.
  - Fungicides which are used to manage fungi.

- Learning how to use all of these methods appropriately to manage pests, protect human health and the environment is what this unit is all about.

**Lesson One Instructor Notes:**
LESSON TWO
MODERN PEST MANAGEMENT
INTRODUCTION TO PEST MANAGEMENT

Learning Objectives:

At the completion of this lesson students will be able to:

1. Define and describe the components of an ecosystem
2. Define terminology associated with Integrated Pest Management
3. List the steps for successful pest management
4. Inventory their own surroundings to identify pest management practices that may already be in place

Materials:

1. Citizen’s Guide to Pest Control (pages 3-5)
2. Pesticide Education Manual Chapter One
3. “Urban Pest Management”, Cornell Cooperative Ext. Fact Sheet #1
4. Student Lecture Guide

Procedures for Evaluation:

1. Student guide evaluation
2. Home inventory evaluation
3. Class participation for brainstorming, and pest management practices evaluation of school grounds

Session Outline

1. **Student Activity:** Brainstorming for student ideas of pest management practices
2. **Lecture:** The components of successful pest management
3. **Student Activity:** Observation of pest management practices around
the school

4. **Homework Assignment:** Home/site inventory of pest management practices

**Student Activity:** Have students break into small groups. Instruct groups to spend 5 minutes brainstorming to come up with as many pest management practices they can think of, each group should list their ideas on a large piece of paper that can be posted and referenced throughout the unit. Hopefully, this will lead to a class discussion that brings out different viewpoints.

**Lecture Points: The components of successful pest management**

- Our world is full of plants, animals, and other organisms that all co-exist as part of an **ecosystem**.

- An ecosystem is a given set of organisms, organic residues, physical and chemical components, and conditions such as, light, temperature, and other related conditions.

- Ecosystems are made up of biotic (living) sub-systems and abiotic (non-living) sub-systems. The food chain is an example of a biotic sub-system. An example of an abiotic sub-system would be the interaction of chemicals from the atmosphere and land with the water in a stream.

- There are **three parts to a complete ecosystem**.
  
  - **Producers** - green plants that produce new food
  
  - **Consumers** - those that combine the primary source of food, other chemicals and energy forms and turn them into more complex foods and tissues
  
  - **Decomposers** - Breakdown organic materials back down into their original components for re-use in the ecosystem

- Everything on earth is part of one or more ecosystems. It is important to remember that, in each ecosystem, if you do something to one part, it effects some or all parts of the other interrelated ecosystems.

- Most of the players in the ecosystems that surround us can be beneficial to people, but some can also be pests.
- Remember the definition of a **pest** is, “an organism (weed, insect, fungus, disease organism, etc.) which causes injury to humans, desirable plants, or animals.”

- For example, rabbits are cute and furry critters, but if they are chowing down on your garden and eating all of the flowers planted around the house, they have now reached the definition of a pest in many people’s minds.

- There are many ways to manage pests -- some are nonchemical and some chemical methods. Knowing your options is the key to successful pest control, and maintaining the delicate balance of the ecosystem.

- Proper pest management is a decision making process, commonly referred to as **Integrated Pest Management (IPM)**. IPM does not necessarily attempt to eliminate all pests. Instead, IPM uses multiple control methods to maintain pest populations at acceptable levels. These methods may or may not include the use of pesticides. The agricultural industry has been using IPM practices for years. Although IPM may take more time and management, using IPM practices around the home can help reduce the amount of pesticides that may be applied, which is good for your family’s health and also the environment.

The following steps will help with the pest management decision making process.

- **Identify the pest**
  
  - Proper pest identification is important for many reasons. Correct identification is the first step towards proper pest management. If you don’t know what it is you are trying to control - how will you know what options you have for control? Incorrect identification, or lack of identification of the pest, can mean using the wrong control. If a pesticide has been used it may be ineffective in controlling the pest. The result would be that the pest is still present and an unnecessary pesticide has been introduced into the environment.

  - Knowing that you have a mouse in the house is a pretty easy call. You may either actually see the little critter, or find the evidence in droppings, or packaging that has been chewed.
• Other signs of pests are more difficult to identify, and many times can be similar to a symptom that was actually brought on by a totally unrelated cause. For example, symptoms you may think are related to a plant disease can also occur because of poor watering or soil conditions.

• Use resources available to help identify the correct pest. Taking a sample to a local garden center, or checking out a library reference book on gardening and garden pest problems are two options. Check with the local Cooperative Extension office to see if they offer diagnostic services, or if they can suggest a low or no cost service that is available.

• If you decide to use a pesticide take a sample, or picture in your mind, of the pest when you shop for the correct pesticide. Many times pesticides that are for sale to homeowners will have pictures or descriptions on the label that indicate which pests may be controlled by that particular product.

- Determining if the pest is present at a level that action needs to be taken.

• Not every crawly bug needs to be squished under your foot, and some people’s “weeds” are other people’s flowers.

• Pest control does not always mean eliminating all of the pest population.

• In agriculture this decision is easier to make because the bottom line is cost. Crop producers ask themselves: “Has the economic threshold been reached?” The economic threshold is defined by simply determining: Is the expense of the control worth the cost?

  - For example, by monitoring (checking the area to determine at what level the pest is present) a crop producer determines that the pest problem in the fields will cause a loss of $50 per acre.

  - Using careful calculation the crop producer determines that it will cost him $150 an acre to treat the fields with a pesticide.
- In this case the cost of treating the field would far outweigh the loss caused by pest damage.

- Therefore, in this example, the pest problem has not reached the economic threshold.

- In later sections we will discuss methods that crop producers and home owners can use in the decision-making process to control pest problems before they come close to reaching the economic threshold.

  • A home owner’s use of pesticides is not as easily determined, or justified, in terms of economic threshold. Usually, home owners base their pest management decisions on potential health effects (including health effects that may be caused by the pest and the control measures), their own personal views regarding pesticides, pests and how much damage are they willing to tolerate, and/or aesthetic considerations. Aesthetics may be determined by deciding how eye appealing the landscape needs to be, or the necessity of having vegetables in the garden that are perfect.

- To help make pest management decisions home owners need to ask themselves several important questions:

  • Does the lawn need to be totally pest free, or can I tolerate a few dandelions, and other “pests”?

  • Are there certain spots that require treatment, rather than the entire area being treated.

  • Are the “bugs” in my yard really doing damage? Some, such as lady bugs, are actually beneficial in that they will feast on aphids and other insects that do cause damage.

  • Does everything that comes out of my garden have to be perfect, or are a few blemishes or spots okay?

  • Are there plants that could be replaced with more resistant varieties? A resistant variety is one that has been produced with the genetic ability to fight off pest problems.

- Once the pest has been identified, and it has been determined that a control is necessary, the next step is to develop an IPM action plan.

- Knowing your options also gives you a range of choices that provides you with the ability to choose the most practical and safest method of pest control.
• Those choices include, but are not limited to:

- **Non-Chemical Controls**
  - Biological Controls
  - Cultural Methods
  - Mechanical Controls
  - Physical Controls
  - Pheromones

- **Chemical Controls**
  - Synthetic Pesticides
  - Microbial Pesticides
  - Growth Regulators

- The next couple of lessons will discuss these options. Once those options are clear it will be easy to develop an IPM action plan.

- The final step of an IPM plan, which will be discussed during the unit, is **evaluating the results**. Once a pest management plan has been chosen, put into practice, and a reasonable time has been allowed for the control to work, it is important to check and make sure the method actually had the desired effect. For future reference, it is important to keep a record of what control method was used and if the control worked. If you keep this information available, you will know what worked and what didn’t if you have the same problem in the future.

**Student Activity:** Review students’ ideas regarding pest management from the brainstorming activity. Have students break into small groups. Assign a nearby area of the school grounds (cafeteria, family living class room, flower beds, school greenhouse, etc.) for each group to inventory for pest management practices already in place.

**Homework Assignment:** Have students look at their own surroundings (their home, or apartment building, a local park, or other area) and see if they can determine what IPM practices may already be in place.

**Lesson Two Instructor Notes:**
LESSON THREE
MODERN PEST MANAGEMENT
ALTERNATIVES TO CHEMICAL PEST CONTROL

Learning Objectives:
At the completion of this lesson students will be able to:

1. List at least three biological control methods of pest control
2. List at least three cultural methods used for pest control
3. Identify at least three mechanical methods used for pest control
4. Define the concept associated with each pest control option.

Materials:
1. Citizen’s Guide to Pest Control (pages 11-12)
2. Pesticide Education Manual (pages 3 - 4)
3. Materials for aphid experiment (See attached instructor guide)
4. Student Lecture Guide

Procedures for Evaluation:
1. Student guide evaluation
2. Student participation on setting up pest control experiment
3. Student participation in second school site evaluation

Session Outline
1. Student Activity: Review pest management practices from student homework, and school site.
2. Lecture: Alternative methods to chemical pest control
   - Introduction of Aphid Experiment
3. **Student Activity:** Set up aphid experiment, reevaluate school site.

**Lecture Points: Alternative methods to chemical pest control**
- Introduction of Aphid Experiment

**Biological Controls:**

- Use of pest’s natural enemies (*predators*) to control pest problems. Predators control pest problems by attacking, feeding on, or in some way killing other animals. Examples of predators are hawks that feed on small animals, snakes that eat mice and rats, and insects that eat other insects.

- Beneficial predators include birds, such as purple martins, that eat insects.

- Beneficial predators also include insects such as lady beetles (commonly referred to as lady bugs). Lady beetles and their larvae eat aphids, mealybugs, white flies and mites. **Larvae** are the immature form of the adult insects, or other animals that hatch from the egg. Other beneficial insects include: lacewings, spiders, centipedes, and even ants.

  - By attracting these types of predators, purple martins with purple martin bird houses, and insects with “bug friendly” environments, problem pests can be controlled.

- **Parasitoids:** **Parasitoids** are plants, animals or microorganisms that live in, on, or with another living organism for the purpose of using the organism as food.

  - An example of pest control with Parasitoids is when miniature wasps lay their eggs inside the eggs or bodies of insect pests. When the eggs of the Parasitoids hatch, the young Parasitoids kill the host.

**Cultural Controls:** Cultural control practices are those which prevent pests from occurring, or make pests available to predators.

- For example, by using a hoe in your garden you are killing weeds, burying disease organisms, and bringing insect pests to the surface where they are more easily reached by predators, and possible weather conditions which will control the population.
• Properly watering and fertilizing plants produces stronger plants that are better at fighting off pest invasions.

**Mechanical controls:** Mechanical control is accomplished by using devices or hand work to remove insects or diseased tissue, or other pests.

• For example, pruning or picking off diseased plant parts, or clumps of insects provides immediate control. Mulching controls weeds. Traps can be used to catch mice or other rodents. Examples of homemade traps include, placing rolled-up newspaper at locations where earwigs gather, and trapping slugs under boards on the ground. Small cans that are buried so that they are level with the soil will cause pests to fall into the can and drown.

**Physical controls:** This method includes changing the environment so pests can not survive, interrupting the life cycle of the pest, or killing the pest.

• Physical controls depend on being able to make changes in the temperature, available moisture, and humidity. As a result, physical controls are not often easily accomplished in the home landscape. One example of a physical control would be to remove puddles of standing water so that pests will not be attracted to the area.

• Indoor pest control is easier to accomplish with the use of physical controls. For example, changing the location of house plants to areas where they get more/less light as necessary to control pests, and controlling the timing of watering are examples of physical controls.

**Pheromones:**

• **Pheromones** are chemical substances that are released by organisms (including insects) for the purpose of communicating with others in the same species.

  - Pheromones are used in three ways, to monitor the presence of pests, to confuse pests so they don’t mate, and to control pests.
• **Monitoring** (refer to Lesson Two student guide for definition) of pests is done by using pheromones on sticky cards. When the pest is attracted to the pheromone it sticks to the card and number of pests on the card are counted to determine if there is a high enough population to make control necessary.

• Man-made pheromones are used for pest control by luring pests into a trap. Ask students to think of an example they may have seen in a garden center. If they can not think of an example a suggestion might be to select volunteers to check out the local garden center and make a list of available pheromones. A second option would be to bring in a Japanese beetle pheromone trap, and other pheromone traps sold at the local garden center. A common mistake made when using these methods is placing the traps in the wrong location. Many times the traps are placed in the flower beds where the pest has been located. Why is this not the best place for the trap? *If students don’t come up with a reason -- ask leading questions like... What is the purpose of the trap--- to draw the pest to the trap. If you put the trap in the flower bed what will happen--pests will be drawn to the trap but if they fail to get caught in the trap you have drawn them into the environment where they can feast on your flowers, which is exactly what you were trying to prevent.* The best location for these traps is in an area away from the plants that need to be protected.

• The biggest use of pheromones is when they are spread over a wide area to confuse the pest and interfere with mate-finding behavior. If they can’t find a mate they won’t produce more of the same pest.

Setting up an aphid control experiment will help understand how some of the methods just discussed may work. (See aphid control lab instructions in the instructors packet)

**Lesson Three Notes:**
Aphid Experiment:

This experiment was originally designed to show the effectiveness of four types of treatments. However, YOU MUST CHECK YOUR STATE REGULATIONS REGARDING THE USE OF PESTICIDES IN SCHOOLS. For example, the Pennsylvania Pesticide Control Act was recently amended and now prohibits the use of ANY pesticide in a common area of the school where students will be present, unless that application is made by a certified pesticide applicator. This includes pesticides that can be purchased at the local garden center such as insect sprays, rat or mice bait etc.. This law does not prohibit teachers from applying these treatments at home and bringing the plants to school for demonstration purposes. If the decision is made to use demonstration plants that have been treated with a pesticide, although it is not necessary to handle these plants with chemically resistant gloves, however, it is recommended for extra precaution.
LESSON FOUR
MODERN PEST MANAGEMENT
REDUCING THE POTENTIAL FOR PEST PROBLEMS

Learning Objectives:
At the completion of this lesson students will be able to:

1. List at least three methods that can be used to prevent pests indoors
2. List at least three methods that can be used to prevent pests outdoors
3. Identify at least three practices that may reduce the need to use lawn chemicals.

Materials:
1. Citizen’s Guide to Pest Control (pages 6-10)
2. Pesticide Education Manual Chapter One
3. “Urban Pest Management”, Cornell Cooperative Ext. Fact Sheet #1
4. Student Lecture Guide

Procedures for Evaluation:
1. Student guide evaluation
2. Class participation in home/site inventory evaluation
3. Evaluation of differences in first and second home/site, and school site inventory of pest management practices

Session Outline
1. Student Activity: Review pest management practices from student homework.
2. Lecture: Indoor and outdoor pest management. Practices that may help to reduce use of lawn chemicals.
3. Student Activity: Set up aphid experiment.
4. Homework Assignment: Take another look at pest management practices.
5. Student Activity: Assignment of final project. Review pest management practices from student homework.
Lecture Points: Indoor and outdoor pest management.
Practices that may help to reduce use of lawn chemicals.

- Pest survival requires air, moisture, food, and shelter. Pests will invade environments that satisfy these basic needs for survival. Eliminating or altering these types of environments goes a long way towards controlling pest populations.

- Methods to eliminate “pest friendly” environments indoors include:

  • **Remove water.** This can be accomplished by fixing leaky plumbing, not leaving water in trays under house plants or in buckets and other containers for any length of time.

  • **Remove potential food for pests.** Storing foods in sealed glass or plastic containers is the best defense. In addition, keep food scraps and garbage in tightly covered garbage cans. (This includes the half eaten candy bar hiding under your bed!)

  • **Remove or close off potential hiding places for pests.** Filling in cracks and crevices with caulking, removing broken wood, and patching holes not only seals off potential hiding places, but also helps with the general up-keep of the house.

  • **Block pest entryways.** Install screens on floor drains, windows and doors. Replace worn-out weather-stripping and repair holes in existing screens.

- Methods to eliminate, or alter, “pest friendly” environments outdoors are very similar to indoor practices, but also include:

  • **Remove hiding places.** Keep wood piles and mulches 12-18 inches from the house. Destroy diseased plants, plant parts pruned from trees and shrubs, decayed fruits and garden vegetables.
- **When possible, eliminate pest breeding sites.** This includes removal of pet droppings; they attract flies and other pests that can spread disease organisms, such as bacteria. Keep areas clean of garbage and puddles of standing water.

- **Take good care of trees, shrubs and outdoor plants.** The first step with this pest management practice is planning. Plant the types of perennials, annuals, trees and shrubs that will grow best in local conditions. Make sure to use healthy plants, if they get a good healthy start plants are more likely to resist pests. In addition, choosing pest resistant varieties will decrease the potential for problems.

- **Mulch** not only helps to control weeds, it also helps to maintain even soil temperature. If mulch is used around the base of trees, it is important that the mulch be kept away from direct contact with the bark of the tree. Mulch that is placed too close to the base of trees could invite pests that may feed on the delicate tissues of small trees. Mulch should also be removed and replaced, or worked into the ground to increase organic matter, every couple of years so that it does not become a breeding ground for pests. This is especially important if there is a severe pest outbreak in a certain area because some pests may hang out (overwinter) in the mulch.

  - **Tips for your garden** (this includes container and patio gardens)
    - If your garden is large, **alternate rows of different kinds of plants.** Pests that prefer one type of vegetable may not spread as easily because not all pests feed on the same type of plants. (Maybe planting a few brussel sprouts, or spinach would do the trick - especially if pests hate them as much as some people do!)
    - **Don’t plant the same crop in the same row or container each year.** If there are pests that overwinter, the new type of plant may not be on the pest’s diet and the plant may be left alone.
    - **Make sure the soil is healthy.** If the soil becomes tightly packed together (compacted) air and water cannot get to the roots. Compaction of the soil can be corrected by using a hoe,
or a tiller to break up the soil. At the same time adding sand, cow manure and other organic matter to the soil can help reduce future soil compaction. A soil test can help to determine if additional fertilizers will help improve the soil; it also will tell the pH of the soil. Knowing the pH of the soil is important because some plants (azaleas, rhododendrons, and holly plants) grow best in acidic soils, while most garden plants need more neutral soil. The Cooperative Extension office or a local garden center are the best sources for soil test kits.

- **Mulch** for gardens should be either straw, hay, shredded bark or grass clippings. Although there is no hard evidence that would indicate a potential problem, it would be best not to use grass clippings if the lawn has been very recently treated with a herbicide. Remember, the purpose of herbicides is to kill green plants!

- **Tips for reducing the need for lawn care chemicals** are very similar to garden practices, but also include:

  - **Mow grass often, make sure blades are sharp, and mowing height is about 2.5 inches.** Grass that is slightly longer and cut with sharper blades, rather than beaten down with dull blades, is stronger and healthier, which means it will be able to put up a better fight if attacked by pests (which is another way of saying that it is more resistant). Allowing the grass to grow slightly longer is not a good excuse to get out of mowing all summer, grass is not 10 times more resistant if you let it grow 2.5 feet tall!

  - **Water deeply, and at the proper time.** When the color of the grass becomes dull, or your footprints stay in the grass for more than a few seconds, this is a sign that the grass needs to be watered. This may be difficult if water restrictions are called for, however, if you can water the grass, watering should not be done during the hottest part of the day because it will quickly evaporate. Also avoid watering late in the evening. The standing water that may result is a perfect environment for disease to occur. This same practice applies to other plants.

  - **Eliminate excess thatch buildup.** Thatch is the layer of dead plant material between the blades of grass and the soil.
When it gets too thick, more than 3/4”, it prevents water and nutrients from getting to the roots. Other than renting a “dethatcher”, the best way to reduce this problem is by raking.

- **Set realistic pest control goals.** A healthy lawn will probably always have a few weeds, insects and other pests. Healthy lawns will also have beneficial insects that help keep problem pests under control.

- **Use synthetic pesticide only when, and where necessary.** Remember to consider whether the whole lawn needs to be treated, or if there are certain spots where pest problems exist. If there are only certain trouble spots, making applications to just those spots will help reduce the amount of pesticides introduced into the environment.

**Student Activity:** Assignment of final project. (See teacher support materials)

**Lesson Four Notes:**
LESSON FIVE
MODERN PEST MANAGEMENT
PESTICIDE REGISTRATION AND REGULATION

Learning Objectives:

Students will be able to:

1. Define terminology used in the registration and regulation of pesticides.
2. Outline the registration process a pesticide must go through to become a marketable product.
3. Outline the federal and state laws that regulate pesticides.

Materials:

1. Penn State Pesticide Education Manual (pages 98 - 102)
2. Citizen’s Guide to Pest Control and Pesticide Safety
3. Information from state regulatory agency (Address and phone number located beginning on page 45 of Citizens Guide to Pest Control and Pesticide Safety.)
4. Student lecture guide
5. Circle of Food Safety Fact Sheets: Reducing Pesticide Residues: The government’s role and the role of the chemical company.

Procedures for Evaluation:

1. Student lecture guide
2. Participation in student activity

Session Outline

I. Lecture: The process of pesticide registration

II. Lecture: State and Federal agency responsibilities
(Note: This is a rather lengthy and complex topic, consider breaking students into groups to research one aspect of the regulatory process and have groups report back to class.)

III. Student Activity: Research an aspect of state regulatory responsibilities
Lecture Points:  The process of pesticide registration

- The manufacturers of synthetic pesticides have an important role in minimizing or eliminating chemical residues in food crops to make sure they are safe for consumers and the environment. Pesticide product development is a lengthy and expensive process with many built-in safety checks.

- Development of a pesticide is estimated to take 8 to 10 years and cost $40 to $60 million dollars. Studies required for registration can cost up to $800,000 each and are responsible for much of the expense and time needed to develop a pesticide. Safety checks, widely recognized as necessary protections for the pesticide applicators, workers in fields treated with pesticides, and consumers of treated food crops, include:
  - **Toxicology**— potential health effects that the pesticide may have on humans or wildlife
  - **Crop residues**— levels at which the pesticide may be present in the crop
  - **Environmental fate**— what happens to the pesticide when it reaches the environment.

- Research generally is done on more than 10,000 compounds before a successful candidate is found for a potential pesticide.

- Once a compound is identified and studied in a controlled laboratory setting, field tests are conducted in the greenhouse and in small plots on research farms. The purpose of these tests is to confirm that the compound does control a pest, or pests, under “real world” conditions.

- The product is also applied at various rates and with different application methods to determine how it will perform in actual growing situations. These tests also show any effect that soil type, rainfall, and other field conditions may have on the pesticide’s performance.

- Potential health effects, including those which are short term or acute, are determined by a number of experiments.

- Detailed studies show what happens to the compound in an animal’s body, how it is distributed or broken down, and how long it stays in the body.
- At the same time, long-term animal feeding studies are conducted to detect any long-term (chronic) ill effects on growth or bodily functions. These feeding studies are also conducted to determine if the product has any cancer-causing properties.

- In addition, separate feeding studies over several generations of test animals look at chemical effects on reproduction or offspring.

- The cost of this research accounts for more than one-fourth of the total cost of developing a new agricultural chemical. All of the research data (information from test results) must be submitted along with a company’s request for product registration to the Environmental Protection Agency (EPA). After examining the data, the EPA decides whether to register a product and allow it to be marketed.

- A major focus of concern stressed by public interest groups is that older pesticides registered before the current process was put in place do not always meet today’s standards. For many years the EPA has been going through the process of reregistration of any pesticides that were put on the market before 1988. Those pesticides must now meet present standards. Information available on these pesticides is reviewed by the EPA to identify additional data that must be provided. The manufacturer of the pesticide must then either conduct the research required by the EPA or stop marketing the pesticide. In some cases, companies have found that it is not cost-effective to spend the millions of dollars needed to provide data required for product registration and they stop manufacturing chemicals that have been on the market for years.

- In the past few years manufacturers of synthetic pesticides have increased efforts to help reduce the amount of pesticides used, as well as the safety of products now on the market.

- In addition to making biological and genetic advancements, manufacturers are developing pesticides that are applied in ounces per acre rather than the usual pounds per acre.

- Products also are being packaged and made in different formulations to reduce possible exposure to the applicator and the environment. (The formulation is the physical structure of the pesticide or pesticide mixture. The same pesticide may be sold as a liquid, dust, or a granular formulation.) For example, some pesticides that were made in
the form of granules were causing problems because birds would eat granules that were on the top of the ground. When the birds ate the granules many got sick and/or died. As a result those pesticides are now made in liquid or other formulations.

- EPA is speeding up the registration process for new chemicals which are considered safer because lower toxicity or increased environmental friendliness.

- Once all of the necessary data is collected by the manufacturer it is submitted to the EPA for registration consideration.

Lecture Points: State and Federal agency responsibilities

- Pesticides have in one way or another been regulated since near the beginning of the 1900’s

- The first major legislation that was enacted specifically for pesticides was written in the late 1940’s. This was about the time when synthetic (man-made) pesticides were first used in large amounts.

- Before the Environmental Protection Agency (EPA) was formed in 1970, the Department of Health, Education, and Welfare was in charge of regulating pesticides.

- All of the laws that govern pesticides and their use must come from Congress or the State Legislature. Through the years there have been several major laws which regulate pesticides. As scientists and others learn more about the effects of pesticides these laws have been improved with amendments.

- Today pesticides are regulated under the Federal Insecticide Fungicide and Rodenticide Act (FIFRA). FIFRA is amended as often as necessary to keep up with technology, safety standards and other scientific advances.

- Three federal agencies are in charge of regulating pesticides. In addition, most states have their own regulations that compliment FIFRA. The state regulations may be more strict that FIFRA, but they can’t be more lenient.
- The **Environmental Protection Agency (EPA)**:
  - EPA is responsible for regulating the sale and use of pesticides in the United States. All pesticides must be registered by EPA before they are legally allowed to be sold.

- When information is submitted by a company asking for permission to register a new pesticide, the EPA does not just take the companies word that the data is correct. The data is also checked by the EPA to make sure that the results are accurate.

- When the proposed use of a pesticide shows an unacceptable risk the registration may be denied for all uses or just those that would result in an unacceptable risk. For a new chemical, either production and sale of the product will not be allowed, or specific uses of the product will be denied. If a chemical that is already on the market shows the possibility of unacceptable risk, the uses of that chemical could be modified to reduce the risk, or the registration could be canceled and the product taken off the market.

  - For example:
    - A company wants to register a pesticide to control weeds. The data submitted shows that there may be health risks if that pesticide is used on fields which are planted in crops to be used for human food.

    - The data also shows that there is **NOT** an unacceptable risk when the pesticide is used on areas such as weed control along power lines, golf courses etc.

    - The use for food crops could be denied. However, the product could be registered for uses that do not show a chance of unacceptable risks.

- Based on the potential health and environmental effects, pesticides are grouped into one of two classifications.

  - **General Use**: Pesticides that may be sold to and used by the general public.
• **Restricted Use:** These pesticides are not available for us by the general public because they are more poisonous (have a higher toxicity) and/or increased environmental hazards.

- Pesticide residues in foods are regulated by the EPA under the Federal Food, Drug and Cosmetic Act (FDCA). The FDCA gives the EPA the authority to set residue tolerances. **Tolerances** are the legally enforceable maximum amounts of pesticide residues allowed in foods. When requesting approval for the registration of a pesticide the manufacturer must submit the results of scientific studies showing residue levels present on the crop under the following conditions:
  
  - when the most applications allowed by the label are made
  - the applications are made at the highest rates allowed by the label,
  - the applications are made at the closest time allowed before harvest.

- Tolerances are established on the basis of this “worst-case scenario.”

- Setting tolerances is a process which takes several steps.

  - Establishing dietary safety factors begins with experiments on laboratory animals to determine the highest daily doses of pesticides that the most sensitive test animal can tolerate. This no observable effect level (NOEL) is then divided by a safety factor of 100 or more to set what is called a **reference dose**.

  - The reference dose represents the maximum amount of a specific pesticide residue that an average person can consume daily over a 70-year lifetime without expecting ill effects.

  - The next step is to establish a tolerance level, which is the maximum amount of pesticide residue that can be allowed in a certain food or feed crop. Tolerances do not necessarily represent levels of pesticide residues which actually occur on crops. The tolerance value is the most extreme number, the maximum amount of residue allowed at the time of harvest. Many food processing practices, such as washing, heating, and storage reduce the amount of pesticide residue that was on a
crop at the time of harvest. In most cases, few or no pesticide residues remain when the crop reaches the marketplace. The amount of pesticides likely to be found in foods after processing, called post-processing residues, more closely represents residues that consumers may be exposed to in processed foods.

- The EPA considers a number of different concerns when deciding whether a residue tolerance should be allowed, and at what level that tolerance should be set. Two of the most important questions considered when establishing a tolerance are:

  - Will one part of the population, for example, infants and children, eat more of a certain food and therefore possibly consume more of the pesticide residue?
  - Will exposure to the chemical over an extended period of time possibly cause cancer?

- The Food and Drug Administration (FDA):
  - Enforces the pesticide tolerances set by Environmental Protection Agency (EPA) on all foods produced in the United States and in foreign countries (except meat, poultry, and fresh egg products). They do this by taking random samples of fresh fruits, vegetables, and other food crops, and test them to see if they have pesticide residues higher than the established tolerance or if there are illegal residues of unregistered pesticides on the crops.

- The United States Department of Agriculture (USDA):
  Food Safety and Inspection Service (FSIS):

  - Does the same thing as the FDA however they only monitor meat, poultry and fresh eggs for pesticides residues.

- Each state also plays an important role in regulating pesticides. Some states have laws that are more strict than the federal laws. Many states also do random sampling of foods for pesticide residues.

  - For example, at the state level, California has a system for the regulation of pesticides and pesticide residues in foods that is stricter than the federal agencies just discussed. In many cases
California analysis for pesticide residues on foods are very similar to the results shown by the FDA. (See pie charts on Circle of Food Safety Fact Sheets.)

**Student Activity:** Break students into groups. With materials available from the state regulatory agency assign each group an aspect of the state pesticide regulations to research and report back to the class. Examples of topic could include, but are not limited to:

- Are your state’s pesticide regulations stricter than Federal Standards?
- What type of applications require certification or licensing?
  - What are the certification requirements for applicators?
- Do pesticides applications have to be reported to a state agency? What information should be reported?
- Notification requirements. Do companies have to notify property owners near the application site before making applications?
- Is there a state registry for notification of people who are hypersensitive to pesticides? What are the requirements to get on the registry? What responsibilities do applicators have to notify people on the registry?
- Does the state have any requirements or recommendations for the use of pesticides in schools?

- **Reminder:** Have students check aphid experiments

**Lesson Five Instructor Notes**
LESSON SIX
MODERN PEST MANAGEMENT
PESTICIDE LABELING

Learning Objectives:
Students will be able to:
1. List, define, and identify the major parts of the pesticide label.
2. Identify special precautions that must be taken when the product is used.
3. Distinguish between a pesticide label and a Materials Safety Data Sheet (MSDS).
4. Define the pesticide user’s responsibility to follow the directions and requirements listed on the label.

Materials:
1. The Penn State Pesticide Education Manual (Chapter 8)
3. Copies of pesticide labels
4. Sample MSDS
5. Student Guide

Procedures for Evaluation:
1. Label/MSDS comparison evaluation
2. Student guide evaluation

Session Outline
I. Lecture: Parts of the pesticide label, legality, user liability
II. Student Activity: Identifying parts of a label vs. parts of the MSDS
III. Session Summary: Pesticide Label, MSDS’s Comparison
Lecture Points: Parts of the pesticide label, legality, user liability

- The most important thing to remember about pesticide labels is that they are legal documents and it is important that all precautions on the label are followed to prevent damage or injury to humans or the environment. You should read the label before purchasing, mixing or applying the chemical. IT IS AGAINST THE LAW TO TRANSPORT, APPLY, STORE, OR DISPOSE OF A PESTICIDE IN A MANNER THAT IS INCONSISTENT WITH THE LABEL.

- Once the manufacturer submits all the necessary data, the EPA reviews the information and can either reject the product or assign an EPA Registration Number.

  • **EPA Registration Number**: This number shows that the EPA has approved the sale of the product and approved the product label. EPA’s major consideration in approving pesticides for sale is that when label directions are followed there is minimal or no risk to human health or the environment. The EPA registration number must appear on all labels of that particular product. It is illegal to sell a pesticide product, or make claims that a product has pesticide properties, if it has not been assigned an EPA Registration Number.

  • **EPA Establishment Number**: This number tells the location where the chemical was actually produced. This is important in case there is a problem with a chemical. The product can be traced back to the place where it was made. For example, a major chemical manufacturer was producing a fungicide (a chemical that controls certain fungus problems), there was a concern that at one of the places the product was being packaged the fungicide was accidentally mixed with a herbicide (a chemical that controls weeds). When the contaminated chemical was applied to control the fungus problem, sensitive plants would be killed by the herbicide. Because there was an EPA Establishment Number on the container of the contaminated fungicide, the manufacture could tell at which manufacturing plant the contamination occurred, and the product from only that manufacturing plant had to be recalled.
- Other information that MUST be on the label includes:

  - Name and address of the manufacturer
  
  - The precautionary statement:
    “KEEP OUT OF THE REACH OF CHILDREN”
  
  - A Signal Word: Signal words “Warning signs” on the label that indicate the toxicity of the pesticide to both humans and animals. Signal words are based on the pesticides LD$_{50}$ value. LD$_{50}$ values are assigned based on how much of the chemical it takes to kill 50% of the test population of animals. LD$_{50}$ values will be discussed in more detail in the next lesson.

- Signal words include:

  - **Danger (with the skull and crossbones)** -
    The LD$_{50}$ is between a trace amount and 50/mg/kg

  - **Danger** - The LD$_{50}$ is the same as Danger with the skull and crossbones, and it could possibly irritate the skin and eyes.

  - **Warning** - The LD$_{50}$ is between 50 and 500 mg/kg.
    One teaspoon to one ounce could be fatal to a 150 pound person.

  - **Caution** - LD$_{50}$ values are 500 mg/kg and above.

- Understanding signal words is also important to help select the least toxic pesticide available for proper control of the pest.

- **Classification Statement**: If a pesticide is a RESTRICTED USE pesticide it must say so on the label, otherwise it can be assumed that the pesticide is a general use chemical. (Review terms from previous lesson)

- Additional information on the pesticide label can be broken down into specific parts which include:
• **Trade/Brand Name:** This is name given to the product by the company that is selling the product. Different manufacturers sometimes have different names for the same chemicals. For example, what used to be known as Paraquat and sold by Chevron Chemical Company, is also known as Gramoxone and now sold by Zeneca Agricultural Products.

- Reading the Ingredient Statement is the best way to determine what is in the product.

• **Ingredient Statement:** This must list the following:

  - The **active ingredients** in the pesticide and the percentage of each active ingredient in the product. Active ingredients are the chemical or chemicals in the product that allows it to control a specific pest. The active ingredient can be listed as the chemical name or the common name. (These will be defined after the ingredient statement)

  - The percentage of **inert ingredients** in the product. The inert ingredients are the inactive ingredients in the product which do not directly control a pest. Individual inert ingredients do not have to be listed on the pesticide label, only the total percentage of all of the inert ingredients in the total product.

• **Chemical Name:** The scientific name of a chemical which comes from the chemical structure of the active ingredient.

• **Common Name:** A name given to an active ingredient by a recognized committee. Common names are given to active ingredients because many times chemical names are too complicated.

- To help clear all of this up, let’s use Roundup herbicide for example:
  - Roundup would be the brand/trade name given by the manufacturer
  - Glyphosate would be the common name
  - The chemical name is N-(Phosphonomethyl) glycine, in the form of isopropylamine salt.
- Ask students to determine the percentage of active and inert ingredients on the Roundup label

**Net contents:** This is found on the front of the label and tells how much is in the container (liquids are in ounces or gallons, dry formulations are in ounces or pounds)

**Directions for use:** This tells how to apply the product and to which crops it can be applied. These directions include:

- Rates: How much can be used
- What pest or pests the product will control
- The crop or animal the product can be used to protect
- Mixing instructions
- Reentry statements - If a certain amount of time must pass before anyone can go back into the area that has been treated.

- Other precautions on the label include:

  - **Preharvest or Preslaughter intervals:** These are listed as the minimum days that must pass between the last pesticide application and the harvest of the treated crop or slaughter of the treated animal. These are set by EPA to allow time for the pesticide to breakdown. This prevents the presence of residues greater than allowed tolerances.

  - **Routes of Entry statements:** Routes of entry refers to the way pesticides can enter the body. Routes of entry will be discussed in more detail in the next lesson. Many pesticides are poisonous by more than one route. For example, a DANGER signal word that says “May be fatal if swallowed”, is much different than “Corrosive-Causes eye damage and severe skin burns.”

  - **Specific Action statements:** Usually follow routes of entry statement. They tell specific things that should or should not be done when using the pesticide. For example:
    - Do not breathe vapors or spray mist
    - Do not get on skin or clothing
    - Do not get in eyes
• **Statement of Practical Treatment:** Immediate first aid treatments recommended in case of poisoning. Also listed are antidotes which can be given by physicians or emergency response personnel when appropriate.

• **Physical or Chemical Hazards:** This section warns of any special fire, explosion or chemical hazards of the chemical.

• **Storage and Disposal:** All labels have general instructions for storage and disposal. However, state and local laws are so different that specific instructions are not included. General instructions include statements such as:
  - Triple rinse this container and offer for recycling, or dispose of in approved landfill.
  - Do not reuse container, render unusable.
  - Do not contaminate water, food, or feed by storage or disposal.

- **Material Safety Data Sheet** In addition to the pesticide label each chemical must have a Material Safety Data Sheet (MSDS). The MSDS has much of the same information as the pesticide label. The major difference between the label and the MSDS is that the MSDS has more detailed information in some areas. A complete MSDS will include the following things that are not on a regular label:
  - Hazard Identifications
  - Department of Transportation (DOT) shipping information
  - OSHA information
  - More detailed protective clothing and safety measures
  - Exposure limits if any are established
  - Specific fire protection information
  - Flash point (at what temperature will it burst into flames)
  - Special fire fighting procedures
  - More detailed health effects summary
  - Specific LD50 information from completed studies
  - Physical data - Information about pH and color and odor of the pesticide.
  - More detailed environmental effects

**Student Activity Assignment:** Using the Roundup label have students identify the parts of the label and MSDS.

**Lesson Six Notes:**
LESSON SEVEN
MODERN PEST MANAGEMENT
HEALTH EFFECTS OF PESTICIDES

Learning Objectives:

Students will be able to:

1. Define toxicity, LD$_{50}$, LC$_{50}$
2. Determine the approximate LD$_{50}$ of the pesticide category by signal word
3. Determine how the concepts of risk, toxicity and exposure are interrelated
4. List the four possible routes of pesticide entry into the body
5. Describe the general symptoms of pesticide poisoning and appropriate first aid measures

Materials:

2. Penn State Pesticide Education Manual
3. Student guide

Procedures for Evaluation:

1. Student guide evaluation

Session Outline

I. Lecture: Risk = Toxicity X Exposure

II. Lecture: Routes of exposure and poisoning symptoms

III. Student Activity: First Aid Chart
Lecture Points: Risk = Toxicity X Exposure

- First let’s start by saying that, with few exceptions, pesticides are poisonous, they are designed to kill something. By understanding a few simple concepts it is easy to determine a pesticides level of toxicity.

  • **Toxicity**: Tells the pesticide’s level of poison, or the capacity of the pesticide to cause injury.

- Even though all pesticides are poisonous, the MOST important thing to remember is this simple formula:

  \[
  \text{Risk} = \text{Toxicity} \times \text{Exposure}
  \]

- Simple math would tell us that to reduce the amount of risk, we have to reduce one of the factors on the other side of the equation. To do that we have to understand what these factors are all about.

- First let’s look at exposure. The important thing to understand about exposure is that there are FOUR ways a pesticide can enter the human body commonly called:

  • **Routes of Entry**

    - **Dermal** : (Through the skin) This is the most common route of pesticide entry into the body. Studies show that 97% of all exposure to pesticides is through the skin. Different parts of the body absorb pesticides easier than others. The head and the groin are the areas most sensitive to pesticide absorption.

    - **Inhalation** : (Through breathing into the lungs) This route is more common when using a powder or spray. Once pesticides get into the lungs, they go quickly into the blood. Even if they don’t cause poisoning by getting into the blood, they can cause damage to the nose, throat, or lung tissue.
- **Oral**: (Through swallowing) This happens most often when pesticides have been taken from their original container and put into unlabeled soda bottles or food containers. Another common mistake that allows pesticides to be swallowed is when pesticides are siphoned and the applicator uses their mouth to start the flow of pesticides through a hose.

- **Through the eyes**: Eyes are sensitive to many pesticides. Eye exposure can be caused by a splash or rubbing the eyes with hands or clothing that are contaminated with pesticides.

- The lesson following today’s lesson will discuss ways to reduce potential human exposure.

- **Toxicity** is classified into two categories

  - **Chronic and Acute Toxicity**

    - **Chronic Toxicity**:  
      The ability of a pesticide to cause poisoning from exposures over long periods of time. Some examples of chronic toxicity include, the ability of the pesticide to cause cancer, reproductive problems, and other long term effects on the body.

    - **Acute Toxicity**:  
      The ability of a pesticide to cause poisoning from a single short term exposure. Acute toxicity is the most common measure of the pesticides level of toxicity. The acute toxicity of a pesticide is determined by doing tests on laboratory animals. These tests are done to determine what is called the LD$_{50}$ of the pesticide.

    - The LD$_{50}$ is the amount or dose of the pesticide which kills 50% of the exposed test animal population. A lower LD$_{50}$ number means that it took less of the chemical to kill 50% of the test population, so it would be a more poisonous chemical.
- So what does an LD\textsubscript{50} number really mean. If a pesticide has an LD\textsubscript{50} of 50, it means that it took 50 milligrams of the pesticide per kilogram of the test animals body weight to kill 50\% of the test population.

- If a pesticide had an LD\textsubscript{50} of 200 what would that mean?
- Which of the pesticides would be more poisonous?

- Another abbreviation that tells how poisonous a pesticide would be is an LC\textsubscript{50}. This stands for the Lethal Concentration of the chemical, usually in air or water, necessary to kill 50\% of the test population.

- Rather than expect everyone to know the LD\textsubscript{50} of each pesticide, the LD\textsubscript{50} values have been used to group pesticides according to their toxicity and assign those groups “Signal Words” which were discussed in the last lesson.

- A review of the signal words:

  • **Danger Poison with a skull and crossbones:**
    - These are the most poisonous chemicals. The LD\textsubscript{50} values range from a trace amount to 50 mg/kg. As little as a few drops taken through the mouth could be deadly to a 150-pound person.

  • **Danger without the skull and crossbones:**
    - This means that in addition to the fact that these are poisonous chemicals they can cause possible skin or eye irritation.

  • **Warning:**
    - The chemical is “moderately toxic”.
    - The LD\textsubscript{50} values range between 50 and 500 mg/kg, and from one teaspoon to one ounce could be fatal if swallowed.

  • **Caution:**
    - These pesticides are the least toxic, however they are still poisonous. The LD\textsubscript{50} values are above 500 mg/kg.
- Remember if you have a choice of more than one pesticide product that will have the results you are looking for, it is best to choose the product with the signal word that indicates the least toxicity.

- Because of the increasing bilingual population, most pesticides also list the signal words in Spanish

  • **Spanish Signal Words**

    - Peligro = Danger
    - Aviso = Warning

- Most pesticide poisonings are either related to exposure on the job, or accidental exposure. Many times accidental exposure is due to pesticides being stored in food containers, most commonly soda bottles. Pesticides should always be stored in their original container and NEVER stored in any type of food container.

- If someone is suffering from pesticide poisoning they may show any or all of the symptoms. Most symptoms appear immediately. However, the symptoms may not appear for as long as 36 - 72 hours after the exposure. **Describe symptoms on page 55 of the Pesticide Education Manual.**

- When a pesticide exposure or poisoning has occurred it is important to act quickly. It is also important to act correctly. For example, never enter an area where a pesticide leak is suspected without proper respiratory protection.

- **General First Aid Instructions:**

  • **Dermal exposure:**
    - If a pesticide contaminates the skin, flush immediately with water.
    - If contamination is severe, remove contaminated clothing and gently wash off the contamination, do not scrub the skin.
    - DO NOT attempt to neutralize the chemical or apply any salves or ointments.
• **Oral exposure:**
  - Dilute the pesticide to prevent absorption.
  - DO NOT induce vomiting if the chemical is a corrosive, a petroleum or petroleum based product, or if it is a strong acid or alkali (base). The reason for this precaution is because if the person has swallowed one of these types of chemicals, the chemical has most likely burned tissues on the way down, and will burn them again on the way up the throat.

• **Eye exposure:**
  - Hold the eyelid open and flush with water for about 15 minutes,
  - Cover the eye with a clean cloth
  - See a doctor immediately.

• **Inhalation exposure:**
  - Get the victim to fresh air immediately.
  - DO NOT attempt to rescue someone from a closed containment area unless you are wearing protective equipment.

- Additional first aid information can be found on the pesticide label in a section titled practical treatment. Remember this section lists antidotes and treatment which physicians and emergency personnel can administer. If a pesticide exposure occurs that requires medical treatment, remember to take the pesticide label with you.

**Lesson Summary**

- All pesticides are poisonous and should be handled with care.

- A quick way to determine a pesticide’s level of poison is to find the signal word.

- Symptoms of pesticide poisoning are very similar to symptoms of high blood pressure, flu or other illness. Symptoms should not go untreated. However, assuming pesticides exposure has caused the illness may result in overlooking other health problems. It is important to consider all possible cause of the symptoms.

- If someone is suffering from a pesticide poisoning, it is just as important to act CORRECTLY, as it is to react quickly.
Sometimes “helping” may do more harm than good if the wrong actions are taken. Remember, if someone has swallowed a corrosive pesticide, or a pesticide with a petroleum base, making them vomit may cause more damage.

- The best place to get information in the case of a pesticide poisoning is by calling the nearest Poison Control Center or the National Pesticide Telecommunications Network (NPTN) at 1-800-858-7378. Dialing 911 is not possible in some rural areas, so emergency phone numbers should be listed where you can find them in a hurry.

- Whenever a pesticide poisoning occurs, no matter how “minor” it seems, it is always best to get help from a doctor or Poison Control Center. Remember, always take the label of the pesticide that caused the exposure along with you to the doctor. The label has information to help the doctor treat the exposure.

- Most importantly, remember the formula:

\[
\text{Risk} = \text{Toxicity} \times \text{Exposure}
\]

- Risks can be reduced in many ways:
  - By reducing the amount of pesticides you use
  - By using the least toxic pesticide available
  - Reducing your exposure when using a pesticide

**Student Assignment:** Students will make an emergency phone list, including their doctor, emergency number for ambulance, Poison Control Center, and EPA emergency number.

- **Reminder:** Have students check aphid experiments

**Lesson Seven Instructor Notes:**
LESSON EIGHT
MODERN PEST MANAGEMENT
REDUCING HUMAN AND ENVIRONMENTAL EXPOSURE TO PESTICIDES

Learning Objectives:
Students will be able to:

1. Identify personal protective equipment requirements on the pesticide label.
2. Identify items of personal protective clothing and equipment, determine when they should be used and define the terms associated with protective clothing and equipment.
3. List reasons why protective equipment may fail to protect against exposure.
4. List practices that may help to reduce environmental exposure due to mishandling of pesticides.

Materials:
1. Pesticide labels
2. Personal protective clothing (see Resources Ordering Information for details)
3. Materials for exposure experiment (see Resources Ordering Info. for details)
4. Pesticide Education Manual (Chapter 9)

Procedures for Evaluation:
1. Student guide evaluation
2. Student activity evaluation

Session Outline
I. Lecture/Demonstration: Protective Equipment
II. Exposure Experiment: Black Light Demonstration (optional)
III. Lecture: Avoiding environmental exposure due to improper pesticide handling practices
IV. Student Activity: Using pesticide labels and the Pesticide Education Manual, students will list precautions that can be taken to minimize unnecessary environmental damage.
Lecture Points: Protective Equipment

- Reducing human and environmental exposure to pesticides is a matter of using good old common sense. Most importantly, until sprays have dried, dusts have settled, or adequate ventilation have been provided, **DO NOT** allow pets and children to play on or around recently treated surfaces.

- Most exposures to pesticides happens when mixing and applying pesticides, entering areas where pesticides have been applied, or cleaning up pesticides.

- The best rule to follow is: If you are using a pesticide, or will be in an area where pesticides have been used or spilled, wear the minimum protective clothing.

  • **Minimum protective clothing includes:**
    - Long-sleeved shirt
    - Long pants, or coveralls
    - Gloves
    - Proper footwear
    - Glasses or goggles are not part of minimum protective clothing, but wearing them is a good idea.

- The type of clothing and equipment needed depends on the type of job you are doing, and the type of chemical being used. For most jobs the minimum clothing listed above will be enough. However, minimum does not mean any old thing will do.

  • **Gloves**-
    - Should be unlined and waterproof.
    - Should cover over your wrist.
    - Should also be checked often for holes, which can be done by filling them with water and squeezing them.
    - Should be made of chemically resistant rubber.
      - Some kinds of rubber react with chemicals and the gloves may dissolve or become sticky.
    - Cotton gloves are out because they will soak up the chemical.

  • **Shoes**-
    - Should be made of rubber or covered by rubber boots.
      - Like cotton, leather soaks up chemicals.
• Pants
  - Should be worn outside of the boots so chemicals won't run down into the boots or shoes.

- Clothing worn when applying pesticides should be washed at the end of the day. This clothing should be washed separate from the family laundry.

- For certain pesticide application jobs more protective clothing is necessary. The pesticide label or more specifically the Material Safety Data Sheet (MSDS) should tell you if you need extra protection.

- Extra protective clothing may include:
  
  • Respirators protect against breathing chemicals into the lungs.
  • Goggles or face shields should always be worn when there is a chance that pesticides could get into the eyes.
  
  • Chemically resistant aprons should be worn when ever there is a chance of splashing chemicals during mixing.
  
  • Raincoats should be worn when working with pesticides that are sprayed overhead or when there may be a chance that sprays could get clothing wet.

Exposure Experiment: (Optional)

- The purpose of this experiment is to show students how they can be exposed to pesticides, using a black light and florescent dye.

Procedures:

- Students can either work in pairs or small groups.

  • First “exposure”:
    - Purpose: To demonstrate the importance of wearing gloves.
      
      • Have one student put a glove on one hand and not on the other. (You may also want to have one student put on a glove with holes in it to stress the importance of checking for holes and tears.
These students will then handle the paper coated with dye.

• Have the student remove the glove but remind them not to touch anything with that hand.

• With the room dark, turn on the black light to show students exposure.

**Second “exposure”:**
- **Purpose:** To demonstrate the importance of wearing minimum protective clothing.

• Have a student with long sleeves put on gloves, and a student with short sleeves also put on gloves.

• Allow students to sprinkle a small area with the dye as if they were applying dusts to roses or vegetable plants.

• With the room dark, turn on the black light to show students exposure.

**Third “exposure”:**
- **Purpose:** To demonstrate the importance of washing hands before removing gloves after using pesticides.

• Have two students put gloves on both hands.

• Have students handle paper coated with dye.

• Have one student rub their cheek, nose or forehead. (As a safety precaution remind students to keep hands away from their eyes.)

• Have one student remove gloves, and simulate picking up food to eat.

• With the room dark, turn on the black light to show students exposure.
- Wearing protective clothing can seem like a burden, or even be uncomfortable in warmer weather. However, as we have seen by these simple demonstrations it is necessary to reduce exposure to pesticides.

- Although there have been major recent improvements, the label may not always state exactly what protective clothing should be worn.

- General label instructions may include:
  
  • Avoid skin contact:
    - Any parts of the body that may be exposed should be covered. In this case the minimum protective clothing discussed earlier, including gloves, should be worn.

  • Keep from breathing dusts or fumes:
    - Respirator or some type of protection from breathing in fumes, dusts or gases is necessary.

  • Keep out of eyes:
    - Means that safety glasses, goggles or a face shield should be worn.

- There is no need to suit up like a space man just to go out and apply pesticides to your garden or lawn, but you do need to protect yourself. If a label does not list specific protective clothing, the minimum protective clothing should still be worn.

**Lecture Points: Avoiding environmental exposure due to improper pesticide handling practices**

- Several other pesticide handling practices that will reduce the potential for environmental contamination include:

  • **Spill clean-up:** Avoiding spills is extremely important, especially around sink holes, and wells (even wells that are no longer being used) and other areas that could lead to contamination of surface or ground water. It is also important to avoid human exposure to the spill. Protective clothing should be worn during spill clean-up. Proper clean up is based on the “Three C” principal:
- **Control the spill:** For example, if there is a leak in a small container, place it in a larger container to prevent further spillage.

- **Contain the spill:** Build a dike or use proper absorbent material (usually cat litter or saw dust is acceptable, unless the pesticide is a strong oxidizer, such as most pool chemicals) to keep the spill from spreading.

- **Clean up the spill:** Keep adding the appropriate absorbent material to the spill. If possible, dispose of the absorbed material by applying it according to the label directions of the product that has been spilled. Keep in mind that this application may not result in the same control, however, it is the safest, most cost effective way to dispose of the material.

- **Dispose of pesticides properly:**
  
  - The best way to dispose of pesticides or pesticide rinse water is to use it according to the label.

  - NEVER dump pesticides down the drain, or anywhere they can reach septic or storm systems. Some communities have household hazardous waste collection sites. For proper disposal check the label, and follow local laws.

  - If local ordinances permit, small amounts of pesticides can be put in the trash using the following rules of thumb, as long as local laws allow. **(Important note: Because of their potential flammability these rules of thumb DO NOT apply to chemicals that are oxidizers.)** For example, many pesticides that are applied to swimming pools are classified as oxidizers.

    - **Liquids:** In amounts of less than one gallon should be left in the original container. Make sure the cap is on tight, wrap the container in several layers of newspaper.

    - **Dry formulations:** In amounts of 10 pounds or less should be wrapped to prevent leaking. This can be done by wrapping in paper or putting the package in a tight container or bag and taping it shut.
- Small amounts of pesticides, when disposed of in this manner, do not present a hazard to trash collectors or the environment. It is important to remember that, due to their potentially flammability oxidizers, such as swimming pool chemicals, should Not be disposed of in this manner. A properly operated landfill provides a large dilution factor so any possible contamination will reduce the effects of the pesticide to a level that is not significant.

- The best way to protect yourself and the environment from unnecessary pesticide exposure is to use nonchemical controls when possible. If pesticide use is necessary: read the label, use common sense, and carefully apply pesticides only when needed.

Lesson Eight Instructor Notes:
LESSON NINE
MODERN PEST MANAGEMENT
FATE OF PESTICIDES IN THE ENVIRONMENT

Learning Objectives:

Students will be able to:

1. List the methods by which pesticides can move away from the application site.
2. List and describe factors that promote or prevent these processes from occurring.
3. Students will be able to describe how pesticides can contaminate groundwater, and precautions that can be taken to avoid contamination.
4. Explain the difference between point and non-point source pollution.

Materials:

1. Slide set or video - Fate of pesticides in the environment (Optional)
2. Pesticide Education Manual
3. AgChem. Fact Sheet 8: The Fate of Pesticides in the Environment

Procedures for Evaluation:

1. Student guide evaluation
2. Non-point source pollution student presentation evaluation

Session Outline

I. Review: Environmental precautions from pesticide label
II. Lecture: Fate of Pesticides in the Environment
III. Student Activity: Non-point source pollution group reports
IV. Lecture Points: Protecting the environment
V. Home work assignment: Site diagram showing potential application site with potential environmental concerns and how they can be managed to avoid becoming environmental problems.
Lecture Points: Fate of Pesticides in the Environment

- As soon as a pesticide is applied it is affected by many processes

- Factors like the weather, how fast the pesticide goes into the soil, and the ways which the pesticide are broken down, or degraded, all play a big part in how well the pesticide works and how the pesticide affects the environment.

- The processes that affect pesticides are termed the "fate" of the pesticide in the environment.

- These “fate” processes can be divided into three types
  
  • Processes that transfer (or move) a pesticide, or those that have an effect on that movement.

  • The processes that breakdown pesticides, called degradation.

  • Adsorption, the processes that binds chemicals to a surface by physical or chemical attraction.

Understanding the "fate" of pesticide is important for several reasons

- Knowing how the pesticide moves or breaks down can help to get the most control from an application.

  • For example: If a pesticide is easily broken down by a process called volatilization, (which is when a solid or liquid formulation turns into a gas), to get the best control you would want to apply the pesticide when there is a lower air temperature, and a higher humidity, because there would be less chance of volatilization.

- Most importantly, understanding the fate of pesticides can help to prevent damage to non-target plants, animals, and unnecessary environmental damage.

Additional Lecture Points can be developed from Pesticide Education Ag. Chem. Fact Sheet No. 8, or use of the optional slide set.
Lecture Points: Protecting the environment

- There are several major pesticide related environmental issues:

- Groundwater contamination is the biggest concern
  • One third of the population in Pennsylvania - up to 95% of the rural population - relies on groundwater for their drinking water.

- Groundwater is found below the surface of the earth
  • Most groundwater is in:
    - Aquifers: Permeable zones of rock, sand, gravel, or limestone which are filled with water.

  • After pesticides reach groundwater they continue to break down, but at a much slower rate.

  • It is very difficult to clean water once it has become contaminated. The best thing to do is avoid contamination, which can be done by using the common sense practices of IPM.

Student Activity: Non-point source pollution group reports. Each group will report on the previously assigned aspect of Non-point source pollution.

- Class discussion: Review of IPM practices and safe pesticide practices.

  • Monitor the area to determine what pests are present, and if they are present at levels that which require control.

  • Most importantly when possible use nonchemical controls, or non-chemical controls in combination with pesticides.

  • If pesticides are necessary, select pesticides carefully. By understanding the "fate" processes of pesticides you can pick the pesticide which is the least likely to enter groundwater.

  • Reduce the amounts of pesticides applied by making applications only when necessary, and at the lowest rate.

  • Follow label directions: Specifically look for directions that tell how to protect the environment, and when precautions are necessary.
• Measure accurately: This is most important with concentrates. Do not "add just a little extra" to make sure the pesticide will do a better job.

• Consider the weather: Most importantly if it is going to rain do not apply pesticides because there is a better chance of runoff.

- In addition to groundwater concerns, poisoning of wildlife and bees are concerns related to the use of pesticides.

- **Fish and Other Wildlife:**
  - Fish kills most commonly result from contamination of water, which is usually a result of a misuse, spill, or field run off.
    - For example, in the summer of 1992 a train derailed in the mid-west, the only car that was damaged was one carrying an insecticide which leaked into a river. The contamination resulted in a large fish kill.
  - Birds are also affected by pesticides. One of the major reasons that DDT was removed from the market was its negative effects on the shells of bald eagle eggs. The bald eagle egg shells were weakened and the young birds died before hatching, which resulted in a dramatic decline in the bald eagle population.
  - In addition, birds and other animals often mistake pesticide granules and pellets or pesticide treated seed for food. Birds and wildlife, pets, and even children can be poisoned when baits are not put in the proper place.

- The following precautions can be taken to reduce the chance of wildlife poisoning:
  - Use pesticides only when necessary, use the least toxic.
  - Read the label, look for environmental cautions
  - Treat only areas that need it, avoid areas near water and well heads, or trees hanging over streams and ponds.
  - Be careful where you put baits or granular pesticides.
- **Bees:**
  - Bees and other pollinating insects are important for the successful production of fruits, some vegetables and honey.
  - Some pesticides, especially insecticides, can be poisonous to pollinating bees.
  - Most of these pesticide poisonings happen when blooming plants are treated with insecticides and bees feed on the blooming plants. If the bees take the pesticide back to the hive, the whole hive could be contaminated.

- The following precautions can be taken to reduce the chance of poisoning bees:
  - Don't apply pesticides that are toxic to bees when plants are in bloom. Mow blooms off before using pesticides that are toxic to bees.
  - Pick the safest formulation. Dusts are more dangerous to bees than sprays. Granular formulations are usually the least poisonous to bees.
  - Consider weather and time of application. Don't apply when wind will cause pesticides to drift. It is best to make pesticide applications in the evening rather than the morning.

- As a wrap up for the unit, have students apply the principals learned to the drawing they have made of their “dream house”. Students should list ways they can incorporate what they have learned into the pest management they will use in the landscape, inside the house and other areas of the drawing.

- Students should also have completed the aphid experiment.

**Lesson Nine Instructor Notes:**
Proposed Academic Standards for Environment and Ecology

XI. INTRODUCTION

This document includes Environment and Ecology standards that describe what students should know and be able to do in these areas:

4.1 Watersheds and Wetlands
4.2 Renewable and Non-renewable Resources
4.3 Environment and Health
4.4 Agriculture and Society
4.5 Integrated Pest Management
4.6 Ecosystems and their Interactions
4.7 Threatened, Endangered and Extinct Species
4.8 Humans and the Environment
4.9 Environmental Laws and Regulation

The Declaration of Rights, Article 1 of the Pennsylvania Constitution states in Section 27: “The people have a right to clean air, pure water, and to the preservation of natural, scenic, historic and aesthetic values of the environment. Pennsylvania’s public natural resources are the common property of all people, including generations yet to come. As a trustee of these resources, the Commonwealth shall conserve and maintain them for the benefit of all people.” To this end it is our responsibility to develop a citizenry that is aware of and concerned about the total environment and has the knowledge and skills to work toward solutions to current problems and the prevention of new ones.

Environment and Ecology is grounded in the complexity of the world we live in and our impact on its sustainability. The human interactions with the ecosystem and the results of human decisions are the main components of this academic area. Environment and Ecology examines the world with rect to the economic, cultural, political and social structure as well as natural processes and systems. This integration across systems is what sets this academic area apart from all others.

Pursuant to Chapter 4, the Department of Education submitted these proposed standards to the State Board of Education. Prior to any formal adoption, the State Board of Education will be soliciting input from across the Commonwealth.
Environment and Ecology places its main emphasis in the real world. It allows students to understand, through a sound academic content, how their everyday lives evolve around their use of the natural world and the resources it provides. As we move into a more technologically driven society, it is crucial for every student to be aware of his/her dependence on a healthy environment. The 21st century will demand a more sophisticated citizen capable of making sound decisions that will impact our natural systems forever.

These standards establish the essential elements of what students should know and be able to do at the end of grades four, seven, ten and twelve. The sequential nature of this document reflects the need for rigorous academic content that students will be expected to achieve. The standards will help students understand decision-making processes, the art of compromise and problem solving skills. The document reinforces all areas across the grade levels increasing difficulty as the students mature intellectually.

Environment and Ecology is a very engaging academic area that captivates students’ interests in their surroundings of the natural and built environment. The skills and knowledge that are addressed in this area of study will serve as tools for student participation in a democratic world of constantly evolving issues and concerns. As they achieve these standards, students will become aware of the role they play in the community in reaching decisions related to the environment.

The study of Environment and Ecology will allow students to be active participants and problem solvers in real issues that affect them, their homes and communities.

Proposed Academic Standards for Environment and Ecology

Pursuant to Chapter 4, the Department of Education submitted these proposed standards to the State Board of Education. Prior to any formal adoption, the State Board of Education will be soliciting input from across the Commonwealth.
Proposed Academic Standards for Environment and Ecology

<table>
<thead>
<tr>
<th>4.5. Integrated Pest Management</th>
<th>4.5.4. GRADE 4</th>
<th>4.5.7. GRADE 7</th>
<th>4.5.10. GRADE 10</th>
<th>4.5.12. GRADE 12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pennsylvania's public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to:</td>
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A. Know types of pests.
   • Identify classifications of pests.
   • Identify and categorize pests.
   • Know how pests fit into a food chain.

A. Explain benefits and harmful effects of pests.
   • Identify different examples of pests and explain the beneficial or harmful effect of each.
   • Identify several locations where pests can be found and compare the effects the pests have on each location.

A. Identify similar classifications of pests that may or may not have similar effects on different regions.
   • Identify environmental effect(s) of pests on different regions of the world.
   • Identify introduced species that are classified as pests in their new environments.

A. Research integrated pest management systems.
   • Analyze the threshold limits of pests and the need for intervention in a managed environment.
   • Research the types of germicides and analyze their effects on homes, industry, hospitals and institutions.
   • Design and explain an integrated pest management plan that uses a range of pest controls.
<table>
<thead>
<tr>
<th>4.5.4. GRADE 4</th>
<th>4.5.7. GRADE 7</th>
<th>4.5.10. GRADE 10</th>
<th>4.5.12. GRADE 12</th>
</tr>
</thead>
</table>

Pennsylvania's public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to:

**B. Explain pest control.**
- Know reasons why people control pests.
- Identify different methods for controlling specific pests in the home, school and community.
- Identify chemical labels (e.g., caution, poison or warning).

**B. Explain how pest management affects the environment.**
- Explain issues related to integrated pest management including biological technology, resistant varieties, chemical practice, medical technology and monitoring techniques.
- Describe how integrated pest management and related technology impact human activities.
- Identify issues related to integrated pest management that affect the environment.

**B. Analyze health benefits and risks associated with integrated pest management.**
- Identify the health risks associated with chemicals used in common pesticides.
- Assess various levels of control within different integrated pest management practices including increased immunity to pesticides, food safety, sterilization, nutrient management and weed control.

**B. Research and analyze integrated pest management practices globally.**
- Research worldwide integrated pest management systems and evaluate the level of impact.
- Research and analyze the international regulations that exist related to integrated pest management.
- Explain complexities associated with mng from one level of control to the next with different integrated pest management practices and compare the related costs of each system.
ENVIRONMENT AND ECOLOGY TEACHER SURVEY
FINAL REPORT
JULY 1998

Executive Summary

The objective of this study was to determine which of the components of the Pennsylvania Department of Education's proposed academic standards for Environment and Ecology are currently being taught to public school students in 4th, 7th, 10th, and 12th grades throughout the Commonwealth. To accomplish this objective, a survey was developed based on the standards and distributed to a representative sample of Pennsylvania public school teachers. Once the completed surveys were received from the teachers, statistical analysis was conducted to determine: 1) how many schools within each grade cover the components in the proposed standards, 2) was there a relationship between a component being covered in a school and the school being rural, suburban and urban setting, and 3) was there a relationship between grade or school setting and the average score for the nine standard areas. For more details regarding how the survey was developed, how the sample of teachers was selected, how the statistical analysis were conducted and specific results for each grade, see the full report following this summary.

Results indicate that of the 18 watershed and wetlands concepts included on the survey for all four grades, one is not taught by the majority of schools in the sample, 9 are introduced but not completely covered, and 8 are taught. Thus, the majority of these concepts are introduced but not completely covered in the majority of schools (4th, 7th, 10th, and 12th grade) in the study. Further evidence suggests that watersheds and wetlands concepts are more likely to be taught in tenth and twelfth grades and only introduced in seventh grade.

There are 15 renewable and non-renewable concepts included on the survey. Of these concepts, none were not taught, 6 were introduced but not completely covered and 9 were taught. The majority of schools in the study teach Sixty percent of the concepts in this area, across grades. The renewable and non-renewable resources concepts are more likely to be taught in suburban schools than in rural and urban schools and more likely to be taught in tenth grade than in twelfth grade.

Of the 12 environmental health concepts included in the survey, none are not taught, 6 are introduced but not completely covered, and 6 are taught. Further evidence suggests that environmental health concepts are more likely to be taught in suburban schools than in rural and urban schools and more likely to be taught in tenth grade than in twelfth grade.

There are 15 agricultural diversity concepts included on the survey, of these, 9 concepts are not taught, 5 are introduced, and 1 is taught by the majority of schools in the sample. Thus, the majority of schools in the study do not teach agricultural diversity concepts. Additionally, results indicated that if agricultural diversity concepts are introduced in a school, they are more likely introduced in fourth grade than in any of the other three grades.

Of the 13 ecosystems and interaction concepts included on the survey, none are not taught, 1 is introduced only, and 12 are taught by the majority of schools in the study. Thus, the majority of schools in this study reported teaching the ecosystem and interaction concepts in the survey. There is evidence of a trend toward these concepts being more likely to be taught in the twelfth grade than in fourth grade. There is a general trend for these concepts to increasingly be taught as the grades increase.

There are 10 integrated pest management concepts included on the survey. Of these concepts, 4 are not taught, 6 are introduced only, and none are taught by the majority of the schools in the study. There is also evidence of a trend toward these concepts being more likely
to be taught in suburban schools than in urban schools and introduced in seventh, tenth and twelfth grades and not taught in fourth grade.

The 15 threatened, endangered and extinct species concepts included on the survey are taught by the majority of schools in the study (1 is not taught, 2 are introduced, and 12 are taught). Additional evidence indicates that these concepts are more likely to be taught in fourth and twelfth grades and introduced but not completely covered in seventh and tenth grades.

The majority of the 11 concepts relating to human impacts on the environment are introduced but not covered completely by the schools in this study (2 are not taught, 7 are only introduced, and 3 are taught). One concept was rated by the same number of schools as being introduced and taught. The concepts relating to the impacts humans have on the environment are more likely to be taught in twelfth grade and only introduced in the other three grades.

Of the 9 concepts relating to governmental laws and regulations, 3 are not taught, 4 are introduced, and 2 are taught by the majority of schools in the sample. Other findings indicate that these concepts are more likely to be introduced in fourth and twelfth grades and not taught in seventh or tenth grades.

Overall, the concepts which are most often not taught in public schools are the agricultural diversity concepts: Watersheds and wetlands, integrated pest management, human impact on the environment, and governmental laws and regulations are introduced but not covered completely by the majority of schools in the study. Finally, renewable and non-renewable resources, ecosystems and their interactions, and threatened and endangered and extinct species are taught by the majority of schools. Environmental health concepts included in the survey were evenly divided between being introduced and being taught by most schools. The only two standard areas which indicate any trends based on the school setting were environmental health and integrated pest management. Neither of these significant differences between settings were of a large magnitude, so they should only be interpreted as trends rather than meaningful differences. Both of these standard areas tend to be more covered in suburban rather than urban settings (or rural for environmental health concepts only). When the overall mean for each of the standard areas across all four grades is calculated, the following ranking is obtained going from the least frequently taught to the most frequently taught: Agricultural Diversity, Integrated Pest Management, Governmental Laws and Regulations, Watersheds and Wetlands, Human Impact of the Environment, Environmental Health, Renewable and Non-renewable Resources, Threatened and Endangered and Extinct Species, and Ecosystems and their Interactions.

Survey Development

Through a review of the standards, a set of key concepts were generated for each grade (4th, 7th, 10th, 12th) which corresponded to the specific components of the standards within each of the nine areas: Watersheds and Wetlands; Renewable and Non-renewable Resources; Environmental Health; Agricultural Diversity; Ecosystems and their Interactions; Integrated Pest Management; Threatened, Endangered and Extinct Species; Human Impact on the Environment and Governmental Laws and Regulations. The final version of the survey was pilot tested for clarity through a review by public school teachers which were not included in the research sample. Any confusing language was modified as a result of the feedback from these teachers.

The survey asked teachers to answer the following question: “To what extent are the following concepts taught to your students in or by grade 4 (7, 10, 12).” Following this question there was a list of key concepts to which they were to check whether these concepts were: “not taught”, “introduced but not completely covered”, or “taught”. Since the specific components of
the standards were different for each grade, even though the nine areas were held constant, a
survey with different key concepts was developed for each grade.

Selection of Teachers/ Schools

The goal of this study required that there be a representative sample of public
teachers/schools throughout the Commonwealth of Pennsylvania. Representative referring to
geographic location, size of community (student enrollment by county used as a proxy), and
elementary, middle/jr. high and high schools. To select the sample, the following procedure
was used:

1. Obtained a listing of all the public schools within the Commonwealth grouped by
   county.
2. Divided the state into six equal regions: Northwest, Southwest, North Central,
   South Central, Northeast, Southeast, and assigned each county to a region.
3. Divided each county into: rural (<10,000 students), suburban (11,000 – 40,000
   students) or urban (>50,000 students) based on the student enrollment for that
   county.
4. Derived the following distribution of counties:

<table>
<thead>
<tr>
<th>Northwest Region</th>
<th>Northcentral Region</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban</td>
<td>Rural</td>
</tr>
<tr>
<td>Erie</td>
<td>Clarion</td>
</tr>
<tr>
<td>Mercer</td>
<td>Warren</td>
</tr>
<tr>
<td>Butler</td>
<td>Forest</td>
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<td>Crawford</td>
<td>Jefferson</td>
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<td>Venango</td>
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<td></td>
<td>Elk</td>
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<tr>
<td></td>
<td>Tioga</td>
</tr>
<tr>
<td></td>
<td>Union</td>
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<table>
<thead>
<tr>
<th>Northeast Region</th>
<th>Southwest Region</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban</td>
<td>Rural</td>
</tr>
<tr>
<td>Erie</td>
<td>Bedford</td>
</tr>
<tr>
<td>Monroe</td>
<td>Carbon</td>
</tr>
<tr>
<td>Columbia</td>
<td>Pike</td>
</tr>
<tr>
<td>Lackawana</td>
<td>Sullivan</td>
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<tr>
<td></td>
<td>Susquehanna</td>
</tr>
<tr>
<td></td>
<td>Wayne</td>
</tr>
<tr>
<td></td>
<td>Indiana</td>
</tr>
</tbody>
</table>

| Urban            | Suburban           |
| Erie             | Luzerne            |
| Monroe           | Carbon             |
| Columbia         | Pike               |
| Lackawana        | Sullivan           |
|                  | Susquehanna        |
|                  | Wayne              |
|                  | Armstrong          |
|                  | Beaver             |
|                  | Somerset           |
|                  | Fayette            |
|                  | Washington         |
|                  | Indiana            |
5. Within each county, the specific schools were randomly selected to make the following sample design:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Urban</th>
<th>Suburban</th>
<th>Rural</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>30</td>
<td>35</td>
<td>30</td>
<td>95</td>
</tr>
<tr>
<td>7</td>
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<td>10</td>
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</tr>
<tr>
<td>12</td>
<td>30</td>
<td>35</td>
<td>30</td>
<td>95</td>
</tr>
<tr>
<td>Total</td>
<td>120</td>
<td>140</td>
<td>120</td>
<td>N=378</td>
</tr>
</tbody>
</table>

The surveys were mailed to the principals of the selected schools along with a letter requesting that the principal pass the survey along to the appropriate teacher in their school. As an incentive for the teachers to complete the survey, an educational poster was included in the survey packet. The final sample had an overall return rate of 56%.

### Analysis of the Surveys

Upon receipt of the completed surveys, the data was entered into a spreadsheet program analysis. The numbers used for the survey response categories were
1= “concept not taught”, 2=“concept introduced but not completely covered”, and
3= “concept taught”. If there were any missing data, these points were omitted from the questions on the surveys (which were different for each grade,) a summary score was created for each of the nine standard areas (which were the same for each grade). Taking the scores for each
question within a given standard area and averaging them together created the summary scores. This was done for every school in the sample. Thus, the summary scores represent the average (mean) score across all the questions which pertain to a standard area for each school. By calculating an average score, this variable became continuous (any number between 0 and 3) rather than discrete (only 0, 1, 2, or 3) as the responses for each question had been.

The data analysis included three types: frequencies, chi-square, and one-way analysis of variance (ANOVA). Frequencies are simply counts of the number of schools which checked that a key concept was “not taught, “introduced but not completely covered”, or “taught” for each question on the surveys. Chi square analysis places all of the frequencies (numbers of different responses) for a given variable of interest in a contingency table to determine whether or not these frequencies were more or less than what we would expect if there was not relationship between the responses (frequencies). Analysis of variance determines if there is a significant difference between the means of more than two groups of subjects for a given dependent variable. A one-way analysis of variance is used when there is only one independent variable.

The analyses were conducted to answer the following questions 1) how many schools within each grade cover the components in the proposed standards 2) was there a relationship between a component being covered in a school and the school being in a rural, suburban, or urban setting, and 3) was there a relationship between grade or school setting and the average score for the nine standard areas?

**Results**

To determine whether or not there was a relationship between a component (or standard area) being covered in a school and the school being rural, suburban, or urban setting, chi square analysis was conducted for each concept and analysis of variance was conducted across all the concepts within each standard area. Only the analysis which were statistically significant will be discussed below. Thus, if there is no notation about rural, suburban, or urban setting differences assume they are similar in how the standard concepts are taught (or not taught).

An analysis of variance was conducted to determine whether or not there was a relationship between grade or school setting and the average score for the nine standard areas. Two separate analyses were conducted to determine 1) if the scores for all four grades were combined, were there differs between schools in rural, suburban, or urban settings and 2) if the scores for all schools in all three settings (rural, suburban, and urban) were combined, were the differences between fourth, seventh, tenth, and twelfth grades in teaching of the standard areas. Only the significant results will be presented in the following section, thus if there are no results, there were no differences either among settings or grades in teaching of the standard areas.

**Integrated Pest Management**

**Fourth Grade Survey**

The mean score for this areas is 1.47. There is only one concept for this area, and it is not taught by the majority of schools.

**Seventh Grade Survey**

The mean score for this area was 1.47. Two of the concepts in this area were introduced, and the majority of the schools do not teach the third concept (pest management practices and their effects).
Tenth Grade Survey

The mean score for this area is 1.91. All three concepts in this area are introduced but not completely covered by the majority of the schools. The analyses determining if there is a relationship between concepts being taught and the school setting show that for the concept “identifying the health risks and benefits associated with pest control”, schools in urban and rural settings are not likely to teach this and suburban schools are more likely to introduce but not completely cover the concept. ($x^2$\(df=4, n=55\)=10.63, \(p=.03\))

Twelfth Grade Survey

The mean score for this area is 1.83. The majority of schools do not teach two of the concepts in this area and one concept (identifying threshold of pests in managed environment) is introduced but not completely covered.

Overall differences Between Schools in Rural, Suburban, and Urban Settings

The statistical difference thought to be significant, are less than overwhelming in magnitude. Thus there is only evidence of a trend for integrated pest management concepts being more likely to be taught in suburban schools than in urban schools (ANOVA \([df=2, n=208, F=4.50, R^2=.04, p=.0021]\))

Overall Differences Between Fourth, Seventh, Tenth, and Twelfth Grades

The statistical differences though significant, are less than overwhelming in magnitude. Thus, there is only evidence of a trend for integrated pest management concepts being more likely to be introduced in seventh, tenth, and twelfth grades, and not taught in fourth grade (ANOVA \([df=3, n=208, F=4.97, =.07, p=.002]\)).
Appendix C
IPM Memorandum of Understanding and Related Information
October 16, 1998

Dr. Winand Hock
The Penn State University
113 Buckhout Lab
University Park, PA  16802

Dear Dr. Hock:

On Wednesday, October 28, 1998, a signing ceremony will be held at the David L. Swartz Intermediate
High School in Carlisle, PA. This ceremony will commemorate a Memorandum of Understanding among
the Pennsylvania Departments of Agriculture and Education and the Penn State Colleges of Agricultural
Sciences and Education to collaborate in bringing integrated pest management into the K-12 schools in the
Commonwealth. We are requesting your presence at this brief ceremony beginning at 1:30 p.m.

Integrated Pest Management (IPM) is the modern approach to managing pests. Integrated Pest
Management uses multiple tactics to manage pests in a safe, economical and environmentally-friendly
manner. Pennsylvania farmers have already derived great benefit from IPM.

IPM is important in two ways to school systems; managing pests on school property and as a teaching tool
where students can study and participate in the management of biological and environmental systems.

Recently there have been some concerns raised by the citizens of Pennsylvania about the way pest control
is carried out on school property. These concerns have included the possibility of exposure of students and
others to pesticides. While IPM does not rule out the use of pesticides, it does provide for a variety of
alternative management approaches that tend to greatly minimize pesticide use.

In addition, IPM is an excellent example of how society has to deal with complex environmental and
economic problems. This fact has been recognized by the Department of Education, and IPM is now
awaiting approval as a learning objective for K-12 curricula in the state. This means that teachers
throughout the Commonwealth will be compelled to use IPM in their lessons. Since IPM includes science,
business, sociology, economics and other disciplines, students will be exposed to the way these disciplines
must be integrated to solve problems.

On behalf of Secretaries Hayes and Hickok and the Dean of the College of Education, I am looking forward
to your presence at the signing.

Sincerely,

[Signature]

Robert D. Steele
Dean

RDS/sn

cc: Samuel Hayes, Jr.    Eugene Hickok    Harvey Golglantz    Edwin Herr
Memorandum of Understanding

Among
The Pennsylvania Department of Agriculture and The Pennsylvania Department of Education and
The College of Agricultural Sciences and The College of Education of
The Pennsylvania State University

Whereas, the Pennsylvania State University's land grant mission is distinctive within Pennsylvania's higher education community, and one focus of that special mission connects Penn State, Pennsylvania government agencies and residents of the commonwealth in the pursuit of excellence for the improvement of life for Pennsylvania's families and youth, and

Whereas, The Pennsylvania State University College of Agricultural Sciences (PSUCAS) has been promoting Integrated Pest management (IPM) for many years through its research, education and cooperative extension programs, and

Whereas, the Pennsylvania Department of Agriculture (PDA), through its agricultural research funds, has funded IPM research projects for the College of Agricultural Sciences, and

Whereas, through a previous memorandum of understanding PSUCAS and PDA have combined their efforts to form the Pennsylvania Integrated Pest Management Program (PAIPM), and

Whereas, the Pennsylvania Department of Education (PDE) has recognized IPM as a learning objective for teaching students in Kindergarten through 12th grade, has recognized the value of agricultural concepts such as IPM for providing new and emerging career options for students, encourages opportunities for integration of the multiple disciplines in the vocational and academic curricula, thus enhancing the academic skills of vocational students and providing real-world experiences for all students, and

Whereas PDE recognizes the value of incorporating agricultural concepts into the basic school curricula with an emphasis of educating the general student population about the importance of the agriculture industry and the role of agriculture in the students' lives, and

Whereas, the Pennsylvania State University College of Education (PSUCE), through research, teaching and outreach, prepares outstanding educators, scholars, and researchers, and
Whereas, the Science Education Group in the Department of Curriculum and Instruction in the PSUCE engages in the initial preparation and ongoing development of exemplary science teachers, science teacher educators, and educational researchers, and

Whereas, the Department of Entomology in the PSUCAS and the Department of Curriculum and Instruction in the PSUCE are engaged in the collaborative development of contemporary science and education courses appropriate for K-12 teachers, and

Whereas, PDA, PDE, PSUCAS and PSUCE agree that IPM has proven value and that further IPM education and promotion will benefit Pennsylvania farmers, students, all Pennsylvania citizens and benefit the environment.

Therefore, The Pennsylvania Department of Agriculture, and the Pennsylvania Department of Education, and the College of Agricultural Sciences and the College of Education at The Pennsylvania State University agree: 1) to cooperate in developing educational materials for use in the public school system of Pennsylvania, 2) to cooperate in conducting educational programs on IPM for Pennsylvania public school teachers and students, 3) to share resources whenever possible in fulfillment of this agreement, 4) to evaluate and identify those IPM concepts and tools most favorable for educational purposes, and 5) to cooperate in an effort to secure additional public and financial support for Integrated Pest Management awareness and education.

Duration:

This Memorandum of Understanding shall become effective upon the date of final signature and shall continue indefinitely. This Memorandum of Understanding may be amended at any time by mutual agreement of the parties in writing, and may be terminated by either party upon 60 days written notice to the other party.

Agreed to:

Samuel Hayes, Jr., Pennsylvania Secretary of Agriculture
Robert Steele, Dean, College of Agricultural Sciences
Chris Herr, Deputy Secretary
Dr. Paul Wangsness, Sr. Associate Dean
Dr. Eugene Hickok, Pennsylvania Secretary of Education
Dr. Edwin Herr, Dean, College of Education
Dr. Thomas Carey, Deputy Secretary
Dr. Peter Rubba, Head, Department of Curriculum and Instruction
Appendix D
Zenger and Zenger
Curriculum Checklist
## STEP I

### I. STATE THE CURRICULUM PROBLEM OR NEED—CONDUCT A NEEDS ASSESSMENT IF NECESSARY.

<table>
<thead>
<tr>
<th>A. IDENTIFY PROBLEM OR NEED</th>
<th>CONSIDERING IT</th>
<th>PLANNING IT</th>
<th>DOING IT</th>
<th>COMPLETED</th>
<th>NOT NEEDED</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. IF KNOWN, STATE THE CURRICULUM PROBLEM OR NEED</td>
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<tr>
<td>2. IF THE NEED IS UNKNOWN OR SHOULD BE VERIFIED, CONDUCT NEEDS ASSESSMENT</td>
<td></td>
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</tr>
<tr>
<td>a. DETERMINE WHAT IS PRESENTLY BEING DONE (WHAT NOW EXISTS), IF ANYTHING</td>
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<td>b. DETERMINE WHAT IS WANTED OR INTENDED</td>
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<tr>
<td>c. SELECT OR DEVELOP DATA GATHERING INSTRUMENT (QUESTIONNAIRE, INTERVIEW GUIDE, ETC.)</td>
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<tr>
<td>d. COLLECT AND ORGANIZE INFORMATION</td>
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<tr>
<td>e. ANALYZE DATA; COMPARE WHAT IS WANTED WITH WHAT ACTUALLY IS IN THE CURRICULUM. THE DIFFERENCE IS THE CURRICULAR NEED.</td>
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<tr>
<td>B. QUICK ASSESSMENT AND COORDINATION OF THE CURRICULUM—IF AN EXTENSIVE NEEDS ASSESSMENT IS NOT DESIRED, OR AFTER A NEEDS ASSESSMENT IS COMPLETED</td>
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</table>
## STEP II

### II. IDENTIFY, REVISE, OR DEVELOP SCHOOL CURRICULUM/PROGRAM GOALS AND OBJECTIVES

<table>
<thead>
<tr>
<th></th>
<th>CONSIDERING IT</th>
<th>PLANNING IT</th>
<th>DOING IT</th>
<th>COMPLETED</th>
<th>NOT NEEDED</th>
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</thead>
<tbody>
<tr>
<td>A.</td>
<td>IDENTIFY, REVISE, OR DEVELOP SCHOOL DISTRICT PHILOSOPHY</td>
<td></td>
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<tr>
<td>B.</td>
<td>IDENTIFY, REVISE, OR DEVELOP SCHOOL DISTRICT (SYSTEM-WIDE) GOALS</td>
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<tr>
<td>C.</td>
<td>IDENTIFY, REVISE, OR DEVELOP GOALS (GENERAL OBJECTIVES) OF PROGRAMS OR SUBJECT AREAS (DISCIPLINES) OF THE SCHOOL CURRICULUM</td>
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<tr>
<td>D.</td>
<td>IDENTIFY, REVISE, OR DEVELOP COURSE TERMINAL OBJECTIVES OF THE SCHOOL COURSES</td>
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<tr>
<td>E.</td>
<td>IDENTIFY, REVISE, OR DEVELOP STUDENT BEHAVIORAL OBJECTIVES OF THE SCHOOL COURSES</td>
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</tbody>
</table>
### STEP III

#### III. PLAN AND ORGANIZE THE RESOURCES AND CONSTRAINTS OF CURRICULUM DEVELOPMENT

<table>
<thead>
<tr>
<th>Step</th>
<th>Consider IT</th>
<th>Planning IT</th>
<th>Doing IT</th>
<th>Completed</th>
<th>Not Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Obtain commitment of Board of Education for Curriculum Development</td>
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<tr>
<td>B. Determine and secure necessary finances for the Curriculum Study</td>
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<tr>
<td>C. Determine availability of qualified personnel within the school system for the Curriculum Study</td>
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<tr>
<td>D. Allof sufficient time for the Curriculum Study</td>
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<tr>
<td>E. Determine availability of facilities, equipment and materials for the Curriculum Study</td>
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<tr>
<td>F. Identify possible constraints or barriers to the Curriculum Study and plan how to overcome them</td>
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</tbody>
</table>
### STEP IV

#### IV. STATE THE FUNCTIONS OF AND SELECT CURRICULUM COMMITTEES USED FOR CURRICULUM PLANNING AND DEVELOPMENT

<table>
<thead>
<tr>
<th>Step</th>
<th>Committee</th>
<th>Functions and Duties</th>
<th>Members</th>
<th>Planning</th>
<th>Completed</th>
<th>Not Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>Citizen's Advisory Committee</td>
<td>1. State the main functions and duties of the Citizen's Advisory Committee for curriculum study</td>
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<td></td>
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<td>2. Select committee members</td>
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<tr>
<td>B.</td>
<td>Curriculum Council</td>
<td>1. State the main functions and duties of the Curriculum Council for curriculum study</td>
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<td></td>
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<td>2. Select committee members</td>
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<tr>
<td>C.</td>
<td>Subject Area Curriculum Committee(s)</td>
<td>1. State the main functions and duties of the Subject Area Curriculum Committee(s) for curriculum study</td>
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<td></td>
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<td>2. Select committee members</td>
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<tr>
<td>D.</td>
<td>Study Committee(s) (Ad Hoc)</td>
<td>1. State the main functions and duties of the Study Committee(s) for curriculum study</td>
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<td></td>
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<td>2. Select committee members</td>
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</tbody>
</table>
V. PLAN AND STATE THE ROLES AND RESPONSIBILITIES OF PERSONNEL INVOLVED

IDENTIFY AND STATE THE ROLE AND RESPONSIBILITY OF THE FOLLOWING INDIVIDUALS FOR THIS CURRICULUM STUDY:

<table>
<thead>
<tr>
<th>Role Description</th>
<th>Considering It</th>
<th>Planning It</th>
<th>Doing It</th>
<th>Completed</th>
<th>Not Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. SUPERINTENDENT</td>
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</tr>
<tr>
<td>B. INTERMEDIATE ADMINISTRATOR, IF THERE IS ONE—ASSISTANT SUPERINTENDENT, CURRICULUM COORDINATOR, ELEMENTARY OR SECONDARY DIRECTOR</td>
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<tr>
<td>C. BUILDING PRINCIPAL</td>
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<tr>
<td>D. SUBJECT AREA (DISCIPLINE) CURRICULUM COMMITTEE CHAIRPERSON</td>
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<td>E. STUDY COMMITTEE (AD HOC) CHAIRPERSON</td>
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<tr>
<td>F. TEACHER WHO IS A CURRICULUM COMMITTEE MEMBER</td>
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<tr>
<td>G. TEACHER WHO IS NOT A CURRICULUM COMMITTEE MEMBER</td>
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<tr>
<td>H. CONSULTANT—IF ONE IS USED</td>
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</table>
STEP VI

VI. IDENTIFY AND ANALYZE POSSIBLE NEW CURRICULA, PROGRAMS, OR OTHER CURRICULAR INNOVATIONS TO MEET THE STATED CURRICULAR NEED

A. IDENTIFY AND LOCATE SEVERAL NEW OR DIFFERENT CURRICULA, PROGRAMS, OR INNOVATIONS. GATHER INFORMATION BY:

1. REVIEWING THE APPROPRIATE PROFESSIONAL, EDUCATIONAL, OR COMMERCIAL LITERATURE

2. CONTACTING THE APPROPRIATE PROFESSIONAL, EDUCATIONAL, OR COMMERCIAL ASSOCIATION’S MAIN OFFICE—NATIONAL, STATE, AND LOCAL

3. CONTACTING COLLEGES, UNIVERSITIES, AND NATIONAL, STATE, AND LOCAL DEPARTMENTS OF EDUCATION

4. SEEKING THE ADVICE OF AUTHORITIES IN THE FIELD

5. ATTENDING MEETINGS AND CONFERENCES RELATED TO THE CURRICULAR NEED

6. VISITING SUCCESSFUL PROGRAMS IN OPERATION

7. SEEKING INPUT FROM LOCAL PERSONNEL

B. ANALYZE NEW CURRICULA OR PROGRAMS BY EXAMINING EACH FOR:

1. PURPOSE—MAIN INTENT, GOALS OR OBJECTIVES

2. ADVANTAGES AND DISADVANTAGES

3. SUCCESSFUL APPROACHES, TECHNIQUES, AND IDEAS

4. NECESSARY FACILITIES, EQUIPMENT, MATERIALS AND RESOURCES

5. COST—FOR PILOT AND/OR SYSTEM-WIDE IMPLEMENTATION
### VII. ASSESS AND SELECT ONE OF THE NEW CURRICULA, PROGRAMS, OR OTHER CURRICULUM INNOVATIONS TO MEET THE STATED CURRICULAR NEED

#### A. ASSESS EACH POSSIBLE NEW CURRICULUM OR PROGRAM

<table>
<thead>
<tr>
<th></th>
<th>CONSIDERING IT</th>
<th>PLANNING IT</th>
<th>DOING IT</th>
<th>COMPLETED</th>
<th>NOT NEEDED</th>
</tr>
</thead>
</table>

1. **DESCRIBE HOW IT WILL MEET THE STATED CURRICULUM NEED**

2. **DESCRIBE HOW IT WILL CONTRIBUTE TO THE GOALS OF THE SCHOOL SYSTEM**

3. **DESCRIBE HOW IT WILL FIT INTO AND WORK IN THIS PARTICULAR SCHOOL SYSTEM IN TERMS OF:**
   - a. **STAFF**
   - b. **STUDENTS**
   - c. **COMMUNITY**
   - d. **FACILITIES**
   - e. **EQUIPMENT**
   - f. **RESOURCES AND MATERIALS**
   - g. **COST**

#### B. SELECT ONE NEW CURRICULUM OR PROGRAM

1. **SELECT THE ONE NEW CURRICULUM OR PROGRAM (OR A COMBINATION OF SEVERAL) THAT SEEMS TO BEST MEET THE STATED CURRICULAR NEED AND FIT INTO THE SCHOOL SYSTEM**

2. **LIST THE REASONS WHY THIS SELECTED CURRICULUM OR PROGRAM SHOULD BE TRIED INCLUDING HOW IT WILL CONTRIBUTE TO THE STATED CURRICULAR NEED AND SCHOOL SYSTEM GOALS**
## VIII. DESIGN OR REDESIGN THE NEW CURRICULUM OR PROGRAM (CURRICULUM DESIGN)

<table>
<thead>
<tr>
<th>Step Description</th>
<th>Considering It</th>
<th>Planning It</th>
<th>Completed</th>
<th>Not Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A.</strong> Select Learning Opportunity (Design) to be Used in the New Program</td>
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<tr>
<td><strong>B.</strong> Identify the Major Areas of Knowledge, Concepts, Topics, Skills, and Content to be Included in the New Program. These could be stated in the form of goals</td>
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<tr>
<td><strong>C.</strong> Identify &amp; Determine Availability of Facilities, Staff, Materials, Equipment, Funds, and Any Other Resources Required for Implementation of the New Program</td>
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<tr>
<td><strong>D.</strong> Determine If and How the New Program Will Fit Into the School System’s Schedule</td>
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</table>

(Use This Checklist If Designing a Course)

<table>
<thead>
<tr>
<th>Step Description</th>
<th>Considering It</th>
<th>Planning It</th>
<th>Completed</th>
<th>Not Needed</th>
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</thead>
<tbody>
<tr>
<td><strong>A.</strong> Develop the Main Purpose of the Course. This can be called Philosophy of the Course</td>
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<tr>
<td><strong>B.</strong> Establish the Course Goals. This includes the major areas of knowledge, concepts, topics, skills, and content to be covered in the course. (Textbooks could be selected at this point; however, it is recommended that they be selected during the next step, implementation)</td>
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<td><strong>C.</strong> Develop Course Terminal Behavioral Objectives (What the Participants Should Be Able to Do After Completing the Course)</td>
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<tr>
<td><strong>D.</strong> Identify and Determine Availability of All Materials and Equipment That Are Necessary to Teach (Implement) the Course</td>
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<tr>
<td><strong>E.</strong> Develop a Course of Study or Some Type of Course Outline to Guide Instruction (Implementation) of the Course</td>
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</tbody>
</table>
## STEP IX

**IX. IMPLEMENT THE NEW CURRICULUM OR PROGRAM (CURRICULUM IMPLEMENTATION)**

<table>
<thead>
<tr>
<th>A. DESIGNATE ONE INDIVIDUAL TO BE IN CHARGE OF IMPLEMENTING THE NEW CURRICULUM OR PROGRAM</th>
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</thead>
</table>

<table>
<thead>
<tr>
<th>B. OBTAIN ALL NECESSARY CLEARANCES (INCLUDING FUNDS, FACILITIES, AND EQUIPMENT)</th>
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<table>
<thead>
<tr>
<th>C. SELECT STAFF AND ORIENT THEM-TRAIN IF NECESSARY</th>
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<tr>
<th>D. SELECT AND PREPARE THE ACTUAL SITE AND FACILITIES TO BE USED</th>
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<tr>
<th>E. SET THE TIME AND SCHEDULE TO BE USED</th>
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<tr>
<th>F. INSTRUCTORS SELECT AND ORGANIZE THE SUBJECT MATTER CONTENT TO BE USED (INCLUDING THE SELECTION OF TEXTBOOKS AND RELATED MATERIAL)</th>
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</table>

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<thead>
<tr>
<th>G. INSTRUCTORS MAKE CERTAIN ALL EQUIPMENT, MATERIALS, AND OTHER RESOURCES NEEDED ARE READY TO USE</th>
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<tr>
<th>H. INSTRUCTORS PREPARE THE INSTRUCTIONAL PLAN OR TEACHING UNIT</th>
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<tr>
<th>I. ASSESS THE NEW PROGRAM AS IT PROGRESSES (FORMATIVE EVALUATION)</th>
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</table>
STEP X

X. EVALUATE THE NEW CURRICULUM OR PROGRAM
   (CURRICULUM EVALUATION)

| A. SPECIFY WHAT IS TO BE EVALUATED—ENTIRE CURRICULUM, SPECIFIC PROGRAM, OR A SPECIFIC SUBJECT AREA, AND FOR WHAT PURPOSE—CONTENT COORDINATION, CONTENT ACHIEVEMENT, ETC. |
| B. DETERMINE CRITERIA TO BE USED TO MAKE THE EVALUATION |
| C. IDENTIFY INFORMATION (DATA) NEEDED FOR THE EVALUATION |
| D. DECIDE HOW TO COLLECT NEEDED INFORMATION (DATA) FOR THE EVALUATION |
| E. COLLECT AND ANALYZE INFORMATION (DATA) FOR THE EVALUATION |
| F. EVALUATE INFORMATION (DATA) AND MAKE DECISIONS |

<table>
<thead>
<tr>
<th>CONSIDERING IT</th>
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Appendix E
Envirothon Evaluation
## STUDENT SURVEY TOTALS

<table>
<thead>
<tr>
<th>Subject Difficulty</th>
<th>Aquatics</th>
<th>Forestry</th>
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<tr>
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<td>5-Too Long</td>
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<td>12</td>
<td>13</td>
<td>5</td>
<td>16</td>
<td>19</td>
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Appendix F
Integrated Pest Management Unit
Knowledge and Attitude
Evaluation Instruments
Integrated Pest Management
Knowledge Instrument

1. List the four types of pest control practices that may be considered when developing an Integrated Pest Management (IPM) Plan:
   ___________________________________________, ___________________________,
   ___________________________________________, ___________________________

2. Which one of the following statements best describes the pest management strategy known as Integrated Pest Management (IPM)?
   A. IPM excludes all synthetic pesticide chemicals as control tactics
   B. IPM utilizes all types of pest control tactics including pesticides
   C. IPM uses only biological control agents to manage pests
   D. IPM programs are only necessary when a public health pest needs to be controlled

Identify the type of pest control methods associated with the following pest control practices:

Use the following symbols: C=Cultural   Ch=Chemical   M=Mechanical
B=Biological   Ph=Pheromone   G=Genetic   Example: _M_ Mouse Trap

3. _____ Using mulch for weed control
4. _____ Insecticidal soap for aphid control
5. _____ Japanese Beetle traps
6. _____ Flea collar on your pet
7. _____ Lady Beetles for aphid control
8. _____ Use of pest resistant plants
9. _____ Rotating the placing of your vegetable plants in your garden from year to year

10. What is the term called to describe toxicity that results from small, repeated exposures to a pesticide over a period of time?
    A. Low toxicity
    B. Acute toxicity
    C. High toxicity
    D. Chronic toxicity

11. Which of the following is a chemical pest control method?
    A. Use of beneficial insects
    B. Fly catcher sticky paper
    C. Pheromone traps
    D. Insecticidal Soap
12. What Federal law regulates the production, sale, transportation, and use of all pesticides?
   A. Food, Drug and Cosmetic Act (FDCA)
   B. The National Pesticide Act (NPA)
   C. The Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), as amended
   D. The United States Pesticide Law (USPL)

13. What is the component of a pesticide formulation called that controls the pest?
   A. Surfactant
   B. Inert ingredient
   C. Active ingredient
   D. Emulsifier

14. What factor is NOT important when initially developing a pest management strategy?
   A. Identification of the pest
   B. Mode of action of the pesticide to be used
   C. Accurate assessment of damage levels
   D. Type of pest management strategies available

15. Which oral LD50 is representative of a highly toxic pesticide?
   A. 40 mg/kg
   B. 75 mg/kg
   C. 580 mg/kg
   D. 1,284 mg/kg

16. Which one of the following terms refers to birth defects?
   A. Oncogenicity
   B. Mutagenicity
   C. Teratogenicity
   D. Neurotoxicity

17. Which statement is NOT correct regarding the use of gloves when handling pesticides?
   A. Wear unlined, waterproof gloves
   B. For most jobs, shirt sleeves should be worn over the gloves
   C. Contaminated leather and fabric gloves can be decontaminated by soaking them in a concentrated dishwater detergent
   D. Wash your gloves with soap and water before removing them to avoid contaminating your hands
18. What signal word(s) appears on product labels where the pesticide causes severe eye damage or skin irritation?
   A. “CAUTION”
   B. “WARNING”
   C. “DANGER-POISON”
   D. “DANGER”

19. Which is the incorrect statement about symptoms of pesticide poisoning?
   A. Often occurs as skin reactions
   B. May mimic heat stroke, pneumonia, or intestinal infections
   C. Can appear almost immediately or be delayed several hours
   D. Always occurs immediately after exposure

20. True or False Before a pesticide can be registered for sale, chemical companies must conduct environmental fate as well as human exposure studies to determine the safety of the product.

21. All pesticides are classified and labeled according to their potential hazards under those circumstances in which they are used. How are these classifications designated?
   A. Homeowner use and professional use
   B. General and restricted use
   C. Toxic and nontoxic
   D. Commercial use and over-the-counter use

22. Which statement about pesticide labels is correct?
   A. Labels are guidelines for applications, but have no legal status
   B. Homeowner product labels are not the responsibility of EPA
   C. Labels are legal documents
   D. Only the portions of the label dealing with health and environmental effects have legal status

23. Which statement does NOT relate to a well defined pest management strategy?
   A. Maintain pest damage at economically acceptable levels
   B. Coordinate the use of multiple control tactics
   C. Evaluate the costs and benefits of each control tactic
   D. Use an eradication approach to control an economically damaging population of pests
24. Which statement about laundering pesticide contaminated clothing is NOT correct?
   A. Contaminated clothing should be washed separately from the family laundry
   B. Use cold water; cold water is more effective in removing pesticide residue than hot water
   C. Use waterproof gloves when handling contaminated clothing
   D. After washing contaminated clothing, rinse the washing machine with and empty load using hot water and detergent

25. What is the improper method of storing pesticides?
   A. Store herbicides separately from other pesticides, fertilizers, and seed
   B. Excess pesticides can be stored in non-food containers as long as they are properly labeled
   C. Storing pesticides in an overhead cabinet which is locked
   D. Small amounts of leftover liquid pesticide can be stored in soda bottles or glass jars

26. Which one of the following is a “Statement of Practical Treatment?”
   A. In case of contact with eyes, flush with water
   B. May irritate eyes, nose, throat, and skin
   C. This product is highly toxic to bees and aquatic organisms
   D. Use goggles or face shield

27. In addition to a current product label, what other document provides specific information about the potential effects of exposure to the pesticide product?
   A. Bill of sale
   B. Material safety data sheet
   C. Supplemental product labeling
   D. Current extension recommendations

28. What are the principal reasons for classifying a pesticide as restricted use?
   A. May cause human and environmental injury
   B. Are very expensive
   C. Require small application rates to control the pest/precise calibration necessary
   D. Require large application rates to control the pest

29. How does the U.S. EPA identify each specific pesticide product used in the U.S.?
   A. EPA identification number
   B. EPA establishment number
   C. EPA registration number
   D. EPA manufacturer’s number
30. Which of the following are examples of pesticide transfer processes?
   A. Volatilization, runoff, leaching
   B. Runoff, photodegradation, microbial degradation
   C. Adsorption, absorption, chemical degradation
   D. Leaching, adsorption, photodegradation

31. Which term best describes a substance or mixture of substances intended for preventing, destroying, repelling, or controlling pests?
   A. Systemic
   B. Pesticide
   C. Eradicant
   D. Synergist

32. Which statement regarding pesticide transfer processes is correct?
   A. Pesticide residues in runoff water can contaminate groundwater
   B. Leaching is most likely to occur with a highly adsorptive pesticide
   C. Once absorbed into plants or animals, most pesticides never break down, and present long term residue problems
   D. Lower vapor pressures tend to be associated with the most volatile pesticides

33. When are chemical control measures justified?
   A. When pest populations exceed the economic injury level
   B. Only when the pest is a public health threat
   C. When the pest population density reaches or exceeds the economic threshold
   D. Whenever any amount of pest damage occurs

34. Except for aerosol containers and gas cylinders, how should all other empty pesticide containers be handled prior to disposal?
   A. Reused without any special handling
   B. Burned
   C. Sent to a recycling facility
   D. Triple- or pressure-rinsed, then rendered unusable

35. **True or False** If a pesticide is swallowed the first thing you should always do is make the person vomit to get the chemical out of their system.
36. Which class of pesticides is most commonly associated with fish kills?
   A. Herbicides
   B. Insecticides
   C. Fungicides
   D. Bactericides

37. Which is the correct first aid procedure if pesticides are splashed into the eyes?
   A. Wash with a warm boric acid solution
   B. Rinse eye quickly with saline solution
   C. Do not do anything until instructed by a physician
   D. Flush the eye for 15 minutes with clean running water

38. Which of the following must be included on every pesticide label?
   A. Directions for use
   B. Keep out of the reach of children
   C. Name and address of the manufacturer
   D. All of the above

39. How do pesticides normally reach groundwater?
   A. Runoff
   B. Microbial activity
   C. Leaching
   D. Absorption

40. List the four specific routes of pesticide exposure:
    ____________________________,  ____________________________
    ____________________________,  ____________________________

41. List the four signal words that may appear on a pesticide label:
    ____________________________,  ____________________________
    ____________________________,  ____________________________

Using the pesticide label and MSDS provided, list the following information:

42. Signal word of this product

43. Personal protective clothing that must be worn when using the product

44. EPA Registration number
45. Number to reach the manufacturer in the event of an accident with this product

46. Percent of active ingredient

47. Oral LD50 of the product

48. List a potential environmental hazard associated with this chemical

49. According to laboratory animal testing, does this product show any potential to cause cancer in humans or dogs? At what dose level were dog studies administered?

50. Are there any reproductive effects associated with this product? How was this determined, be specific?

51-55. Rank the following LD50 values from 1 (lowest) to 5 (highest). (5 points)

___ Nico Soap (Nicotine based insecticide) – LD50 56-60 mg/kg

___ Sketal (Bacillus thuringiensis var. israelensis–microbial insecticide) LD50>5,000 mg/kg

___ Harvacide (Growth Regulator/Defoliant) LD50 1660 mg/kg

___ Harness (Herbicide – Synthetic Chemical) LD50 2690 mg/kg

___ Sevin (Carbamate insecticide) LD50 246-283 mg/kg

56-60. Identify each of the following as either acute (A) or chronic (C) toxicity symptoms. (5 points)

___ carcinogenicity       ___ skin rash

___ eye irritation        ___ birth defects

___ reproductive disorders

61. **True or False** All appropriate or effective alternatives used in insect management are non-chemical and non-toxic.
## Integrated Pest Management

### Attitude Questionnaire

<table>
<thead>
<tr>
<th>Attitude question/ statement</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Don't Know</th>
<th>Agree</th>
<th>Strongly Agree</th>
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<tbody>
<tr>
<td>1. Practicing IPM means that pesticides are not used.</td>
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<td>2. IPM is a process of controlling pests by controlling the environment where they may live.</td>
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<td>3. Practicing IPM is something only farmers do to produce crops.</td>
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<td>4. IPM is a new concept that was just introduced a couple of years ago</td>
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<td>5. One pesticide is as poisonous as another.</td>
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<td>6. For IPM to be considered a success all pests must be completely eliminated.</td>
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<td>7. All insects are pests that cause damage.</td>
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<td>8. The more poisonous the pesticide the more effective it is.</td>
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<td>9. IPM is only about controlling insects.</td>
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<td>10. Pests can be managed in a way that is compatible with nature.</td>
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<td>11. Pest management is only necessary when you see pests present.</td>
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<td>12. Weeds are as much a pest as insects.</td>
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<td>13. Rat poison is always better than a trap</td>
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<td>14. Using an increased amount of a pesticide usually helps to get rid of the pest faster.</td>
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<tr>
<td>Attitude question/statement</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Don't Know</td>
<td>Agree</td>
<td>Strongly Agree</td>
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<tr>
<td>15. Fixing cracks in windows and repairing screens is a good way to control pests.</td>
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<td>16. All insect sprays kill the same insects.</td>
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<td>17. Keeping your room clean and not leaving food and food wrappers around helps control pests.</td>
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<td>18. Pesticides only kill the pests you are trying to kill.</td>
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<td>19. Pesticides are not used to kill things like mold, fungus, or bacteria in swimming pools.</td>
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<td>20. If there are no pesticide residues on foods, that means that no pesticides were used in production.</td>
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<td>21. We don't use pesticides in or around our home</td>
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<td>22. There are not many choices other than pesticides to control pests.</td>
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<td>23. Pesticides can be used as part of an IPM program, but only as a last resort.</td>
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<td>24. It is not important to identify an insect you are trying to control, because most insects can be controlled the same way.</td>
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<td>25. Monitoring to determine how many pests are present is not important, because if they are present pests must be controlled.</td>
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<td>26. Keeping a record of past pest problems will help with future pest control with a higher toxicity.</td>
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<td>28. There is very little information available to help homeowners develop an IPM plan.</td>
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<td>29. There are very few opportunities to practice IPM around the home.</td>
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Appendix G
Human Subject Clearance/
Letters of Consent
Dear Students and Parents:

You/your child’s class has been selected to participate in a research study sponsored by The Pennsylvania State University, Department of Agriculture and Extension Education, and the Office of Pesticide Education. The main objective of the study is to determine if, as a result of receiving instruction, there is an increase in knowledge or change in your child’s attitudes regarding Integrated Pest Management.

Integrated Pest Management (IPM) is the practice of considering a “big picture” approach to pest control, as opposed to relying strictly on the use of pesticides. For example, if a pest can be controlled by using methods such as mulch or beneficial insects (good bugs, like lady bugs, that eat bad bugs, like aphids), less pesticides will be needed around the home. Students participating in the study will be given a pretest to determine their existing knowledge of IPM. After completing a unit of instruction, students will be tested again to determine any increase in knowledge or change in attitudes regarding IPM.

The IPM unit of instruction that will be presented to your child’s class was reviewed by science teachers and other specialists. This unit has been adapted as a result of recommendations made by the teachers and students.

Participation in this research study is strictly confidential. Only the teacher will have access to any information associated with the students identity. In the event that the research is published, students will not be identified in any way.

Please carefully read the attached consent form. If you agree to take advantage of the opportunity for participation in the research study, please sign the attached. The form must be returned to the cooperating teacher before may participate in the study begins. Thank you in advance for taking time to consider this request.

Sincerely,

Kerry Hoffman Richards
Pesticide Education Coordinator and
Agricultural and Extension Education Doctoral Candidate
Student Informed Consent Form

I agree to participate in the research study to evaluate the Integrate Pest Management curricula. I understand that this unit will be taught by my regular instructor, under the direction of Kerry Hoffman Richards as an authorized part of the education and research program of The Pennsylvania State University. I realize that this study will be taught as a part of the regular classroom instruction.

I understand that Ms. Richards will be available to answer any question about the curricula and materials. Ms. Richards may be reached at (814) 865-2134, or at the address listed in the letterhead.

I understand that my participation in this research study is strictly confidential. I also understand that at any time I can decline to answer specific questions. In addition, if I so desire I can request that my information be excluded from the results reported to the researcher.

I understand that a signed copy of this consent form and results of the study when completed will be kept on file with my instructor. If I so desire, upon request, I will receive a copy of this form and the results of the study.

________________________________________
Signature of participant

________________________________________
Date
Parent(s) Informed Consent Form

I agree to allow my child the opportunity to participate in the research study to evaluate the Integrate Pest Management curricula. I understand that this unit will be taught by my child’s regular instructor, under the direction of Kerry Hoffman Richards as an authorized part of the education and research program of The Pennsylvania State University. I realize that this study will be taught as a part of the regular classroom instruction.

I understand that Ms. Richards will be available to answer any question about the curricula and materials. Ms. Richards may be reached at (814) 865-2134, or at the address listed in the letterhead.

I understand that my child’s participation in this research study is strictly confidential. I also understand that if at any time I so desire I can request that my child’s information be excluded from the results reported to the researcher.

I understand that a signed copy of this consent form and results of the study when completed will be kept on file with my child’s instructor. If I so desire, upon request, I will receive a copy of this form and the results of the study.

---------------------------------------------
Signature of parent or guardian of participant

---------------------------------------------
Date

---------------------------------------------
Researcher:
I certify that the informed consent procedure has been followed, and that I have answered any questions from the participants and/or their parent or guardian as fully as possible.

---------------------------------------------
Kerry Hoffman Richards, Researcher

---------------------------------------------
Date
Appendix H
External Summative Evaluation
Instructor Checklist
## IPM Curriculum Evaluation**

<table>
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<tr>
<th>Preface or Forward Includes</th>
<th>Acceptable as it appears</th>
<th>Needs to be improved</th>
<th>Does not appear</th>
<th>Does not apply</th>
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<tbody>
<tr>
<td>Background—brief statement about why the guide was written</td>
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<tr>
<td>Purpose—what the guide is designated to accomplish</td>
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<tr>
<td>Audience—for whom the guide was written</td>
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<tr>
<td>Philosophy—statement of philosophy pertaining to the topic of the guide</td>
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<tr>
<td>Goals—broad, general statements of intended outcomes of the topic of the guide</td>
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<tr>
<td><strong>Organization:</strong></td>
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<tr>
<td>Table of contents with page numbers – makes guide easier to use</td>
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<tr>
<td>Provides a structured and consistent format</td>
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<tr>
<td>Provides space for teacher comments</td>
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<tr>
<td>Provides for adding and replacing pages to encourage revision</td>
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</tbody>
</table>
### IPM Curriculum Evaluation

<table>
<thead>
<tr>
<th>Content: Include of the basic content of each unit. (The outline indicates the proposed sequence of instruction as well as the areas of instruction.)</th>
<th>Acceptable as it appears</th>
<th>Needs to be improved</th>
<th>Does not appear</th>
<th>Does not apply</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allows for differing levels of ability and/or cultural backgrounds</td>
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<tr>
<td>Allows for different races and sexes (content does not stereotype the races or sexes)</td>
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<tr>
<td>Suggests Supplementary Content</td>
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</tbody>
</table>

| Objectives: State the unit/lesson objectives | | | | |
| State objectives in terms of student behavior | | | | |

| Materials and Resources: List required materials and instructional aids | | | | |
| Suggest appropriate resources and/or reference materials | | | | |
| Suggests appropriate instructional media (video, overheads, websites, etc.) | | | | |
| Indicates where instructional media, resource and reference materials are located and how to order them | | | | |
## IPM Curriculum Evaluation

<table>
<thead>
<tr>
<th>Instructional procedures and activities</th>
<th>Acceptable as it appears</th>
<th>Needs to be improved</th>
<th>Does not appear</th>
<th>Does not apply</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suggest and describe a variety of teaching methods and instructional techniques appropriate for achieving the stated objectives</td>
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<tr>
<td>Suggested and described a variety of student learning activities and experiences appropriate for achieving the stated objectives</td>
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<tr>
<td>Suggested procedures and techniques for individualized instruction and independent study</td>
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</table>

### Evaluation

<table>
<thead>
<tr>
<th>Describe testing and grading policies</th>
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<tbody>
<tr>
<td>Describe how testing and grading are developed directly from goals and objectives</td>
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<tr>
<td>Suggest various possible ways of evaluating student progress and achievement of this content</td>
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</table>

**For those areas that need to be improved, what suggestions would you make:**
IPM Curriculum Evaluation

Would you use these materials in your classroom instruction? _____ yes _____ no

Do you think your students would find this unit interesting? _____ yes _____ no

For what grade(s) is this material appropriate ________________________________

What other materials or concepts do you think should be included?

Have you ever taught this type of unit before? _____ yes _____ no

If yes, when ________________________________

If no, why not:

Do you feel the material presented in the unit is:
_____ too easy for the general population in your classes
_____ grade level appropriate
_____ too difficult for the general population in your classes to grasp

Will you probably teach the unit again
_____ yes
_____ no

If yes, would you teach it:
_____ as a complete unit
_____ in parts incorporated into other units

If no, why not?
IPM Curriculum Evaluation

What would you suggest to improve the unit:
_____ more hands on activities
_____ overheads
_____ more audio video materials
_____ other suggestions:

Do you feel the unit:
_____ had too much emphasis on pesticides
_____ was adequately balanced
_____ has too much emphasis on pest control other than pesticides

Vita
Kerry Hoffman Richards

Education:

Doctor of Philosophy: Agricultural and Extension Education Penn State University 1999
Masters of Education: Agricultural and Extension Education, Penn State University 1992
Bachelors of Science: Agricultural Sciences, Penn State University 1983

Professional Experience:

Senior Research Associate, Pesticide Education Coordinator, Office of Pesticide Education, Penn State University, University Park, PA 8/89 – Present
State Coordinator – Pennsylvania Partners for Safer Community A National FFA Initiative out of Indianapolis, IN 1/98 – Present
Secretary/Fund Raising Coordinator, Pennsylvania FFA Foundation, Calder Square, PA 1/94 – Present
Agricultural Education Instructor, Oxford High School, Oxford PA 8/84 – 7/89

Memberships and Awards:
American Association of Pesticide Educators
Pennsylvania Association of Agricultural Educators
Member Gamma Sigma Delta Honor Society
Pennsylvania FFA Blue and Gold Award

Teaching Experience:
Agro. 951 – Pesticide Safety, Penn State’s Two Year Turf Program
Swimming Pool Application Certification and Recertification via Picture – Tel
Pesticide Applicator Update Training Presentations – Too numerous to list

Grants received and solicited:
Development and evaluation of IPM/Pesticide Safety curriculum, Pennsylvania Department of Agriculture (PDA), Co- Investigators, Winand K. Hock and Donald E. Evans - $46,950 12/96 - 12/99
Partners for A Safer Community Train- the Trainer Program, (NIOSH), Co- Investigator, Cynthia Shaffer - $11,000 7/98 – 10/98
Revision and dissemination of IPM/Pesticide Safety curriculum materials Pennsylvania State University – College of Agriculture POW mini grant - $25,000 3/00 – 6/00
Broadening Partners for A Safer Community to Include Health Care Workers, (PDA), Co- Investigator, Cynthia Shaffer-$20,000 7/99 – 6/00