THE COURSE, "PRINCIPLES OF AGRICULTURAL TECHNOLOGY," PHYSICS OR FARCE?

By

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CHAPTER I

INTRODUCTION

For years in the minds of some, secondary Agricultural Education courses have had a reputation of being easy classes, where rural students learn competencies needed for farming, ranching, and other so-called unskilled occupations. It was very common in years past for agricultural students in general to be viewed as job oriented instead of college bound. Today's Agricultural Education students have new challenges facing them as they explore careers. Fewer job opportunities are there for production agriculture fields and jobs requiring college degrees are not increasing. Agricultural related occupations are where job opportunities are, and most agricultural related occupations require knowledge in mathematics and science, or technology. For Agricultural Education classes to be most beneficial the curriculum needs to be more academically focused. Technology must be taught to high school students for them to be competitive in today's job market.

In the late 1980's the Agricultural Education division of the Oklahoma State Department of Vocational and Technical Education began introducing new non-production oriented courses. These new courses were designed to meet the needs of students in Agricultural Education classes in urban as well as rural areas. The courses added challenge students more in the mathematics and science areas. One course dealing with mathematics and science, and directed toward hands-on student participation was Principles of Agricultural Technology.

Principles of Agri-technology (PAT) was started as a pilot program in two school districts in the state of Oklahoma in the 1989-90 school year. PAT was piloted into traditional Agricultural Education classrooms by traditional Agricultural Education instructors (these instructors also had certification in physics on their standard teaching certificates). PAT used the "Principles of Technology" text, a curriculum developed by the Center for Occupational Research and Development, of Waco, Texas. PAT is basically an applied physics curriculum that is directed toward agricultural applications by the Agricultural Education instructor. PAT is still used as part of the curriculum in the Agricultural Education departments in the two school district in which the pilot program was started, and is being taught in other Agricultural Education departments in Oklahoma as well.

Many educators think all students should have some form of physics during high school. Vocational students interested in agriculture are no exception. Roper (1989) commented that physics teachers need to make physics available to students who envision careers that do not require college. He also believes students should be encouraged to take physics even if there is no interest by the student. PAT is a course where vocational students may learn physics' principles within a more comfortable and less threatening atmosphere. In an August 31, 1992 memorandum from the Oklahoma State Superintendent of Public Instruction, Sandy Garrett to

Oklahoma School Administrators, Principles of Agri-technology was said to be an alternative course for high school physics. Garrett (1992) said PAT may be placed on a high school transcript as physics if the instructor was certified in the physics content area. For the first time in the history of Agricultural Education in Oklahoma, an Agricultural Education course could be taken for science credit instead of as an elective.

Problem

Traditional physics courses have done an excellent job teaching the more academically motivated students physics and technology principles. Technology courses being taught by both physics and technology instructors have become quite popular as educators stress the importance of a strong technological foundation. However, in spite of these advances, 80 percent of high school students do not complete a physics course (Cord, 1992). As more physics classes are needed, PAT appears to be one way for Agricultural Education students to receive a working knowledge of physics. After three years of implementation of PAT in Oklahoma Agricultural Education programs it is deemed necessary to evaluate the course. We must ask the question: Can Principles of Agri-technology, an applied physics course taught in a traditional Agricultural Education program, be as beneficial and academically valid toward technological literacy to high school students as regular high school physics and technology courses?

Literacy in this context, means an understanding and an ability to converse, and readily use terms and practices associated with Physics.

Purpose

The purpose of this study was to evaluate physics and technological literacy performance of students enrolled in a high school Physics course, a high school Principles of Technology course, and a Principles of Agri-technology course by means of scores on a teacher constructed physics principles test.

Objectives

In order to achieve the purpose of this study, the following objectives were formulated.

1. To measure high school students' knowledge level of physics and technology at the beginning of the school year as determined by a pre-test.

2. To compare increases in students' knowledge level of physics and technology as achieved through a high school Physics course, a high school Principles of Technology course, and a Principles of Agri-technology course, to be determined through gain scores between a pre-test and post-test.

3. To compare the pre-test and post-test scores on a physics principles test between the students enrolled in a high school Physics course versus a Principles of Agri-technology course.

4. To compare the gain scores on a physics principles test between the students enrolled in a high school Principles of Technology course versus Principles of Agri-technology.

Hypotheses

In order to achieve the objectives of the study the following hypotheses needed to be tested:

Hypothesis 1 - There is no significant difference between the pre- and post-test scores of students enrolled in the high school Physics course.

Hypothesis 2 - There is no significant difference between the pre- and post-test scores of students enrolled in the high school Principles of Technology course.

Hypothesis 3 - There is no significant difference between the pre-and post-test scores of students enrolled in the Principles of Agri-technology course.

Hypothesis 4 - There is no significant difference between the pre-test/post-test difference scores for students enrolled in the high school Physics course versus students enrolled in the Principles of Agri-technology course.

Hypothesis 5 - There is no significant difference between the pre-test/post-test difference scores for students enrolled in the Principles of Technology course versus students enrolled in the Principles of Agri-technology course.

Definitions

Physics Students - Students enrolled in first year physics at Norman High School, Norman, Oklahoma. This course is comprised of 24 11th and 12th grade students.

Technology Students - Students enrolled in first year Principles of Technology at Putnam City High School, Oklahoma City, Oklahoma. This course is comprised of ten 11th and 12th grade students.

Principles of Agri-technology Students - Students enrolled in first year of Agri-technology at Norman High School, Norman, Oklahoma. This course is comprised of nine 11th and 12th grade students.

Curriculums for All Three Test Groups - Curriculums used by all three classes met the Students Learner Outcomes for Physics as set by the Oklahoma State Department of Education (See Appendix C).

Limitations

A noted limitation for this study is the class size found for both the Principles of Technology course and the Principles of Agri-technology. Due to the limited number of classes to choose from, especially the Principles of Agri-technology (because PAT is a pilot course), smaller classes were used. Both Principles of Technology and the Principles of Agri-technology course started the year with more students, but due to circumstances beyond the control of the researcher, the final number of students to complete the course were as is recorded.

Scope

This study was conducted in two metropolitan high schools. The pre-test part of the study was given to one section of first year Physics and one section of first year Principles of Agri-technology at the Norman, Oklahoma High School, and one section of first year Principles of Technology at the Putnam City High School in Oklahoma City, Oklahoma. The post-test portion of the study was given to the same three sections in the same two high schools. This study was conducted during the 1992-93 academic school year.

The total number of students participating in the study were as follows:

High School Physics	N=24
Principles of Technology	N=10
Principles of Agri-technology	N= 9

For students to be considered for the study they had to have taken the pre-test at the first of the school year, remained in the course all year, and have taken the post-test at the end of the academic school year.

Original numbers in the three test classes were larger than the total numbers recorded that finished the courses. Students originally taking the pre-test in the high school Physics courses numbered 28, but only 24 remained in the class during the year. Twenty-two students began Principles of Technology, with some drop-out students and some graduating at mid-term among the top reasons, only ten students completed the course. The Principles of Agri-technology started the year with 16 students. Two students changed courses at mid-term, two students moved out of the district, two students dropped out of school leaving ten students to complete the course. One student, however, was out of school the last three weeks due to illness and was not available for the post-test, so the number of students to be considered in the Principles of Agritechnology course was nine.

CHAPTER II

REVIEW OF LITERATURE

The purpose of this chapter is to provide an overview of the literature as it pertains to, and relates to, comparisons of high school physics related courses. Materials from books, professional journals, magazines, public letters, and other research studies compile the review. For the review to be more understandable these topics will be reviewed: (1) Introduction, (2) Physics, (3) Principles of Technology, (4) Principles of Agri-technology, (5) Perceptions of Oklahoma State Department of Vocational and Technical Education, (6) High School Accreditation, (7) Similar Studies, and (8) Summary.

Introduction

Today many changes are taking place in public education. More emphasis is being put on teaching problem solving skills. Industry and other employers are wanting new employees who can think on their feet. Employees in agricultural fields are no exception (Cook, 1992). Agriculture is an ever-changing industry, and as the National Summit on Agricultural Education (cited by Cook, 1992, p. 11) concluded, "Change is rampant in agriculture and agricultural education must keep pace or become an obsolete remnant of the past." One change in Agricultural Education is in implementing more problem solving principles in science and mathematics into their curriculum.

Physics and technology related courses are also incorporating problem solving skills into their curriculums. Technology education is the fastest growing curriculum in high schools today. High school graduates must have a working knowledge of physics and technology to be highly employable.

It would be hard to find an agricultural field of work where an employee did not work around new technology. Courses like PAT help students learn technology and physics principles that are needed for useful employment. Technological skills can be learned through other physics and technology courses as well. Through this review the author will review several perceptions of physics and technological teachings.

Physics

Teaching physics at the secondary school level has been shaped largely by tradition. In the early years, topics studied by secondary physics students were chosen from a simple list, the topics their teachers studied at universities. Technological achievements received attention in the curriculum as their importance to society warranted (Roper, 1989).

For years physics classes were for our most astute, college-bound students. The majority of secondary school students failed to see the need to study physics. Few female students enrolled in physics classes. Physics was perceived as too difficult, too mathematical, and generally unfriendly to the average student. Some physics texts were written with no application, so students learned physics principles but did not know how to use them. Physics teachers saw the need to make physics available to students who envisioned careers that did not require college. As of late, physics teachers have done more to teach not only academics but applications of physics principles as well (Roper, 1989).

Principles of Technology

Technology is changing the skills needed to hold a job. Industry wants a new kind of worker with a strong foundation of basics in technology (VICA Professional).

A relatively new course for teaching high school students about needed applied technology was Principles of Technology. McCade (1991) says many educators are excited about a course called Principles of Technology (PT). The goal of the course is to give students a foundation for continued learning about technology. The PT curriculum combines three components needed to understand physics: Technology, Applied Physics, and Applied Mathematics. The PT curriculum was developed by two non-profit organizations: The American-Canadian Agency for Instructional Technology (AIT), and the Center for Occupational Research and Development (CORD).

A Principles of Technology brochure (CORD) tells what PT is and why PT should be taught.

Principles of Technology is a high school course in applied science for vocational-technical students in the 11th and 12th grades. The curriculum covers 14 units in applied physics. Units of: Force, Work, Rate, Resistance, Energy, Power, and Force Transformers are covered during the first year. The second year the following units will be covered: Momentum, Waves and Vibrations, Energy Converters, Transducers, Radiation, Optical Systems, and Time Constants.

One reason that PT is taught is because we all live in a sophisticated, rapidly changing society that is becoming increasingly dependent upon an understanding of technology. PT is not an easy course. The scientific content and the academic rigor of the course are carefully sustained, to provide a high quality of instruction and to meet the goals of filling high school science requirements. Most students achieve significant learning and find the course interesting and useful. PT gives students technological literacy.

Principles of Technology's level of difficulty is defined by Chiaverine (1988) for average students; college bound, general studies and vocational and non-college bound, general education.

The Principles of Technology classes are basically divided into three learning criteria: Theory, Math skills, and Laboratory experiments. Many PT classes are taught by the cooperative learning approach. The curriculum is designed for optimum learning no matter which teaching styles are used by the instructor. Witkop (1988) rated CORD tops for technical physics curriculum.

The Principles of Technology course is gaining popularity with small school districts and large school systems as well. With the implementation of PT into high school course offerings more students are studying physics than ever before.

A physics teacher from Pine Bluffs, Wyoming in a letter to Dr. Pedrotti of CORD tells of increases in his enrollment since offering Principles of Technology. He says:

> Please accept my thanks for enabling us to acquaint many more of our students with physics. I can recall enrollments of only 2 students in my traditional physics course, with the usual class consisting of 3 or 4 students. During the 3 years in which we have offered Principles of Technology, we have touched 29 lives. That's 21 more than we would have seen in physics. Even though small classes have enabled me to adapt to my students' needs, I could not cheat my highly skills students of their due. Nor could I bring myself to adulterate the process and content of physics for any reason. Yet providing physics literacy to more than a select group has become an imperative for public education (Weller, 1990, p. 1).

In another letter to Dr. Pedrotti of CORD, a Principles of Technology teacher from Jemez Pueble, New Mexico states:

> I am happy to report that Principles of Technology is the best curriculum package I have ever seen as a teacher for students. Lest you think I make this statement lightly, let me explain my reasons.
>
> 1. About half of the students taking the class are students that not only would not normally take physics . . . they would probably not even take science.
>
> 2. The non-traditional physics students are competing with the rest of the class.
>
> 3. The material actually does what we in education usually only claim to do. It builds on itself and demonstrates the need for what is taught soon after it is taught.
>
> 4. The format for presenting material maintains student interest, reinforces the concepts, and is presented in a non-sexist manner.

5. The material is such that the students can see a need for the math in the course as well as math presented in their regular course.

6. The material is presented in small enough chunks that the students and the teacher are not overwhelmed before they have the opportunity to practice what they've learned in the lab experiment.

7. The lab experiments are real and they work! Please understand that everything does not always come out 'by the book,' but that seems to conform to the real world pretty well.

8. My students are learning.

9. My students enjoy the class.

10. I enjoy the class (Barton, 1990, p. 2).

It is evident from these letters that several teachers agree that the Principles of Technology course is a useful class not only for getting more numbers to take physics classes, but that the course is useful for teaching high school students physics and technology principles.

Principles of Agri-technology

Principles of Agricultural Technology is an off-set of the Principles of Technology course. The same CORD curriculum used in Principles of Technology is used in the Principles of Agri-technology. Where the PT instructors direct their curriculum towards industry and manufacturing, PAT instructors direct their efforts toward applications in the field of agriculture and agricultural related industries. Since PT and PAT use the same curriculum, the main difference in the courses is the settings in which the courses are taught.

Students in rural school districts, and to some extent urban schools as well, feel more comfortable and at ease in the agriculture building. With the family being involved in many of the activities that the Agricultural Education instructors are involved in, many students know the agriculture teacher personally and have been in the agriculture building before they enroll in an agriculture class. This reason alone makes Principles of Agri-technology more appealing to students in rural communities than traditional high school physics.

In a study conducted by the Research Division of the Oklahoma Department of Vocational-Technical Education (ODVTE) several issues and outcomes were discussed (ODVTE, 1990). The following is a condensed list of issues and outcomes that dealt directly with the PAT course.

1. The PAT programs have exposed non-traditional students, including minorities, to agricultural education. In some instances, the PAT students have enrolled in traditional agricultural education class offerings and opted to become active members of the FFA organization.

2. The PAT students strongly endorsed the program. A large majority would recommend the program to others and would take a Principles of Agri-technology II program if available.

3. For the most part, the teachers have endorsed the Principles of Technology developed by CORD. They viewed the curriculum as being well written, easy to use, and challenging to the students.

4. Traditional agricultural education students have a better understanding and appreciation of the academic underpinnings of the agriculture industry.

5. Students successfully completing a PAT class have received a laboratory science credit.

6. Due to the appeal and need for this type of program, the teachers voiced a concern that Principles of Agri-technology could someday become a traditional Principles of Technology program. Obviously, the teachers do not want to be PT teachers. Any class taught in the agriculture building must be agricultural in nature.

7. Several factors appeared to have motivated the teachers to implement a PAT program. Declining enrollment was one such factor. Although the short-term outcome has been increased enrollment, it is important to consider what will be the long-term student outcomes, e.g., employment and educational, as a result of the PAT program.

8. Start-up cost of the program were seen as a major problem from the perspective of the teachers in that, if the Oklahoma Department of Vocational-Technical Education had not provided the grant, the program may not have been implemented.

9. The teachers were ambivalent in regard to discussing indicators of the program effectiveness. In most cases, the indicators were soft, e.g., 'we hope that their math and science skills have improved' and 'the students seem to enjoy the program.'

   In the future, the ODVTE may want to work more closely with the pilot site in identifying and structuring outcome measures and the methodology for determining how well they did. In doing so, we must remain sensitive to the notion of a pilot program.

10. The Principles of Technology curriculum lacks agricultural examples.

11. There was some discussion of altering the instructional sequence to allow small groups of students to demonstrate laboratory exercises to the remainder of the class. The hands-on component of the program would be lost with that instructional alternative.

12. Student deficiencies in basic skills necessitate that the teachers spend considerable time on the review of math exercises (ODVTE, 1990).

The general consensus after teacher and student interview and class observations was Principles of Agri-technology has positive outcomes.

Perceptions of Oklahoma State Department of Vocational and Technical Education

As today's society demands for students to be "field ready" when they leave high school, more and more links must be made between schools, vo-techs, colleges, and work places. One educational plan that does this and is supported by the Oklahoma Department of Vocational-Technical Education is called Tech Prep (ODVTE, 1981).

Tech Prep prepares students for emerging, technologically advanced careers. Applied academics are integrated into high school curriculums so students can learn basic knowledge of technical concepts. Tech Prep gives students options. Instead of a single track to college, students are given lifelong alternatives! The Tech Prep option gives students what they need to be employable and to continue their education after high school graduation. Tech Prep encourages mastery in general course work and technical training (ODVTE, 1981).

The courses offered through Tech Prep are:

1. Applied Mathematics I
2. Principles of Technology I

3. Applied Biology and Chemistry
4. Applied Communications
5. Applied Mathematics II
6. Principles of Technology II

The instructors of these courses work together to align students' curriculums so as not to have students repeat course work. Starting in the 9th grade some of these courses are added to students curriculums to aid in their career goals.

The ODVTE has given approval for Principles of Agri-technology to be used as substitute for Principles of Technology I for participation in a Tech Prep educational plan.

Other states have implemented Tech Prep. Indiana has a Tech Prep pilot and says that the course will be available to all Indiana students by the 1994-95 school year (Hoke and Suba, 1992). Indiana says the tech prep curriculum is an innovative approach for giving a target group of high school students the foundations necessary for working and living in an increasingly technological world. Many states including Oklahoma think that technology education is important.

The Oklahoma Department of Vocational-Technical Education is hopeful that Tech Prep is the answer to career preparation. The ODVTE says the real winners in the quest for technical education is first the student, then the employers, high schools, colleges, and communities. Then America will win with a world-class force for a global market (ODVTE, 1981).

High School Accreditation

With all the talk on Tech Prep and all the applied courses gaining popularity, many states are reviewing their college admission credits concerning applied academics courses. Some states are going to accept most any applied course while other states are going to look hard and long to see if the applied courses offer as much academically as the traditional course.

Four northwestern states and Alaska have been encouraged by a select group of educators, business representatives and policy makers, to have higher education officials review applied academics courses and make recommendations whether such courses are equivalent to academic core courses and whether they meet college preparatory admission standards.

Alaska, Idaho, Montana, Oregon, and Washington have all accepted several applied courses for college admission requirements. Principles of Technology is one of the courses that they feel meet academic requirements (Northwest Connections, 1992).

Oklahoma as well feels that some applied courses are fulfilling the requirements for college entrance credit.

A letter from the Oklahoma State Superintendent of Public Instruction states:

> Many of you have asked questions about the various applied academic courses, particularly with regard to how students could get credit for taking these courses so that they are able to use this credit for college entrance as well as high school graduation. We join you in believing that these courses offer outstanding opportunities for some students to reach higher academic levels than through more traditional delivery systems and

> encourage you to provide your high school students with these courses when possible (Garrett, 1992, p. 1).

Garrett's letter also goes on to say that Principles of Technology or Principles of Agri-technology may be placed on a high school transcript as Physics or Physical Science.

The Oklahoma Department of Education joins the Oklahoma Department of Vocational-Technical Education in acknowledging the importance of physics and technology education for high school students in the state of Oklahoma.

Similar Studies

This section of the review is to provide a look at some of the studies that have been done over applied physics related high school courses. Four studies will be reviewed, one from Iowa, Alabama, Ohio, and Oklahoma.

The Ohio study on the impact of applied academics on the Ohio vocational achievement test scores had 20 vocational schools participate (Harvey, 1991).

This study investigated the effects of program delivery changes from a traditional model to the applied academics model as measured by student performance. Achievement scores for both juniors and seniors were examined for the years 1985 through 1989. Achievement scores from traditional delivery systems were compared to the scores from the applied academics model. The conclusions from this study showed significant decreases in student achievement in the applied academics model. Some possible reasons were cited:

1. It is human nature to resist change. Many teachers felt uncomfortable with the change to the applied academics model.

2. Vocational teachers experience increased responsibilities.

3. Vocational teacher 'time with students' was reduced dramatically.

4. Vocational teacher workload was increased by giving up their planning period.

5. Loss of laboratory 'hands on' and loss of technical theory 'cognitive' time due to compressed vocational school day.

6. Coordination activities between the vocational and academic teachers have not occurred as was intended.

7. Adequate teaching materials may not have been available to academic teachers.

8. Lastly, it should be recognized that much of the change taking place in vocational education is political in nature. Many changes are being implemented without being based on sound educational theory or research.

The factors above lend credibility to the idea that students were not offered the opportunity to learn cognitive skills under the new applied academic model.

For valuable changes to be made in education, prior planning and commitment from teachers and administration is a must. Cooperation was not evident in the Ohio study.

Another study comparing an applied course to a traditional course was conducted in Oklahoma (Beadles, 1992). This study was to assess a pilot program of the Applied Biology/Chemistry curriculum taught using the cooperative learning method as compared to the traditional biology curriculum taught using more traditional teaching methods by means of scores of students on a standardized biology test and an attitude toward science survey.

The basis for the study was that science oriented jobs require the ability to apply the knowledge taught in public school science courses. Most people believe this, but some are still skeptical that an applied course can teach the knowledge gained in a traditional science class.

The study was conducted in a rural town in Oklahoma, where both traditional Biology and Applied Biology/Chemistry were taught.

After evaluation of student learning through pre- and post-test a summary of the findings were that there was no significant differences in the student learner outcomes between students taught in a traditional Biology class and those students taught in an applied Biology/Chemistry class using the cooperative learning method.

An observation was that the students showed a much greater enthusiasm for the applied course, and it is believed that this enthusiasm will foster a greater appreciation and understanding of science and technology as it is used in the real world today.

A study conducted in Alabama compared students enrolled in PT with those students enrolled in traditional physics (Baker, Wilmoth, and Lewis, 1990).

The study consisted of 226 students from PT classes and 306 students from traditional physics classes in Alabama during the 1988-89 school year.

The data gathered through pre- and post-test led to the conclusion that the Principles of Technology course was valid as an academic course, and equivalent to physics in terms of student performance on a standardized test.

In an Iowa State University study (Dugger, 1989) students who used the Principles of Technology curriculum gained more knowledge of basic physics concepts than did traditional physics students.

This two year study consisted of 675 students in 15 Iowa school districts. This study compared PT student performance to student performance of traditional physics.

Again pre- and post-tests were used to determine learner outcomes of the two courses. On the pre-test, traditional physics students scored five points higher than did the PT students. After a post-test was administered the results were different. PT students made up the five points they were behind and then outscored the traditional physics student by 11 points.

The study concluded that, although never intended to replace physics, the Principles of Technology course does a significantly better job in increasing student achievement regarding basic physics concepts.

Summary

The review of literature relating to high school related physics course, applied courses, and primarily the Principles of Technology course, shows a positive view of technology education. The literature shows that a large number of teachers, educators, businessmen, and industry employers alike see a need for technology education for all high school graduates.

Today's students must be prepared to understand, to live, and to work in a technologically driven world (Wicklein, 1989).

One has only to pick-up any magazine to find an article dealing with technology of some kind. Formal research, magazine and journal articles, books and pamphlets make it easy to see that hands-on knowledge of technology is a must for existing and advancing in today's career goals. Educators must try to meet as many technological needs as possible, so not to short change our future--our Kids!

CHAPTER III

DESIGN AND METHODOLOGY

The purpose of this study was to evaluate physics and technological literacy performances of students enrolled in a high school Physics course, a high school Technology course, and a Principles of Agri-technology course by means of scores on a given physics principles test. In order to achieve the purposes of the study, the following objectives were formulated.

1. To measure high school students' knowledge level of physics and technology at the beginning of the school year as determined by a pre-test.

2. To measure increases in students' knowledge of physics and technology as achieved through a high school Physics course, a high School Technology course, and a Principles of Agri-technology course, to be determined through gain scores between a pre-test and post-test.

3. To compare the gain scores on a physics principles test between the students enrolled in a high school Physics course versus a Principles of Agri-technology course.

4. To compare the gain scores on a physics principles test between the students enrolled in a high school Principles of Technology course versus Principles of Agri-technology.

Hypotheses

In order to achieve the objectives of the study the following hypotheses needed to be tested.

Hypothesis 1 - There is no significant difference between the pre- and post-test scores of students enrolled in the high school Physics course.

Hypothesis 2 - There is no significant difference between the pre- and post-test scores of students enrolled in a high school Principles of Technology course.

Hypothesis 3 - There is no significant difference between the pre-and post-test scores of students enrolled in the Principles of Agri-technology course.

Hypothesis 4 - There is no significant difference between the pre-test/post-test difference scores for students enrolled in the high school Physics course versus students enrolled in the Principles of Agri-technology course.

Hypothesis 5 - There is no significant difference between the pre-test/post-test difference scores for students enrolled in the Principles of Technology course versus students enrolled in the Principles of Agri-technology course.

Hypothesis Testing

Hypothesis testing was between pre-test and post-test scores for each of the three test groups. Since each student had a pre- and post-test score, a correlated t-test formula was used to test for significant differences between pre- and post-test scores.

Hypothesis testing was also completed between gain scores of a high school Physics course versus Principles of Agri-technology, and between gain scores of a high school Principles of Technology course versus Principles of Agri-technology. Since enrollment numbers varied for each of the test groups and variances were equal, a Separate Variance t-test was used to test for significant differences between mean gain scores.

The use of a t-test to determine significant differences in the analysis of data was explained by Popham (1973) as follows:

> The t-test is used to determine just how great the difference between two means must be for it to be judged significant, that is, a significant departure from differences, which might be expected by chance alone. Another way of stating the function of the t-test is to assert that, through its use, we test the null hypothesis that two groups means are not significantly different, that is, the means are so similar that the same groups can be considered to have been drawn from the same population (pp. 124-125).

Scope of the Study

This study was conducted in two metropolitan high schools. The pre-test part of the study was given to one section of first year Physics and one section of first year Principles of Agri-technology at the Norman High School, Norman, Oklahoma, and one section of first year Principles of Technology at the Putnam City High School in Oklahoma City, Oklahoma. The post-test portion of the study was given to the same three sections in the same two high schools. This study was conducted during the 1992-93 academic school year.

The total number of students participating in the study were as follows:

High School Physics	N = 24
Principles of Technology	N = 10
Principles of Agri-technology	N = 9

For students to be considered for the study they had to have taken the pre-test at the first of the school year, remained in the course all year, and have taken the post-test at the end of the academic school year.

Institutional Review Board (IRB)

Federal regulations and Oklahoma State University policy require review and approval of all research studies that involve human subjects before investigators can begin their research. The Oklahoma State University Office of University Research Services and the IRB conduct this review to protect the rights and welfare of human subjects involved in biomedical and behavioral research. In compliance with the aforementioned policy, this study received the proper surveillance and was granted permission to continue under approval number AG-93-011 (See Appendix A).

Measuring Instrument

A 100 question test over physics and technology was used as a pre- and post-test for the three test physics classes. The test was approved by all three teachers whose classes were involved in the study.

The test material was taken from over 300 unit test questions found in the Principles of Technology curriculum, and the high school physics instructor allowed no question that was not covered by his traditional curriculum. The topics for questions and number of questions for each topic were as follows:

Unit 1.	Force	15 questions
Unit 2.	Work	15 questions
Unit 3.	Rate	15 questions
Unit 4.	Resistance	15 questions
Unit 5.	Energy	15 questions
Unit 6.	Power	15 questions
Unit 7.	Force Transformers	10 questions

The number of questions was reduced for Unit 7, Force Transformers, because it may not be covered during the first year of PT and PAT classes due to allocation of time.

The Physics principles test was constructed using test questions from the unit tests found in the Principles of Technology curriculum. The Principles of Technology curriculum meets the Student Learner Outcomes for Physics as set by the Oklahoma Department of Education, and the constructed test used for the pre- and post-test in this study covered the Oklahoma Department of Education Student Learner Outcomes.

Questions varied in level of difficulty. Some questions were multiple choice, fill in the blank, true or false, and some math problems were on the test (See Appendix B).

Measurement Procedures

The pre-tests were given to all of the three test groups on the fifteenth day of class. This time was chosen because it was felt the classes would be well constructed at this time. Drops and adds to class should have been completed, and instructors would have students into their daily routines. No class had prior to enrollment knowledge that they would be part of a test group, so the classes were made up of students who elected to enroll in those classes. No grouping had been made as far as test scores, gender, race, color, creed, age, or national origin.

The same test used for the pre-test was used for the post-test. The post-test was given to the three test groups towards the end of the school year. Only those students who took both the pre-test and the post-test were used in the analysis.

Analysis Procedures

This study compared three groups of high school students enrolled in physics related courses. One group was a traditional physics class, one group was a Principles of Technology class using the Principles of Technology (CORD) curriculum, and one group was Principles of Agri-technology class using the Principles of Technology (CORD) curriculum directed toward agriculture by the agriculture instructor.

The quantitative comparison of the students was completed from their pre- and post-test difference scores. Two comparisons were made, one between a high school Physics course versus Principles of

Agri-technology and the other between a Principles of Technology course versus Principles of Agri-technology thus the t-test was used to test for significant differences between the group means. The significance level of .05 was used as the level of acceptance or rejection of each of the formulated null hypotheses. The formula used for comparison of the t-test is shown in Appendix D.

CHAPTER IV

PRESENTATION AND ANALYSIS OF DATA

The purpose of this study was to evaluate physics and technological literacy performances of students enrolled in a high school Physics course, a high school Technology course, and a Principles of Agri-technology course by means of scores on a teacher constructed physics principles test.

Findings of the Study

The following section was included to present analysis of the data collected relative to the objectives of this study.

The distributions of pre- and post physics principles test scores recorded for students in the high school Physics are presented in Table I. Each student is identified by a number at the left margin of the table. The pre-test score, post-test score and difference (or gain) score for each student are listed left to right in the same row following the student's identification number. Pre-test scores ranged from 27.0 to 62.0. Post-test scores observed at the end of the school year for high school Physics ranged from 26.0 to 81.0. There was a mean increase of 14.29 points between pre-test and post-test for the high school Physics course with a standard deviation of 9.295. The number of students enrolled in the high school Physics course fluctuated during the year, but there

TABLE I

DISTRIBUTION OF PRE- AND POST-TEST SCORES FOR STUDENTS ENROLLED IN HIGH SCHOOL PHYSICS COURSE

Student ID. Number	Pre-test (n=24)	Post-test (n=24)	Difference
1	41	53	12
2	43	66	23
3	62	74	12
4	42	49	7
5	32	59	17
6	48	62	14
7	44	70	26
8	35	52	17
9	53	65	12
10	46	66	20
11	32	41	9
12	45	63	18
13	60	81	21
14	36	65	29
15	44	49	5
16	40	55	15
17	38	57	19
18	36	56	20
19	49	36	-13
20	39	59	20
21	27	26	- 1
22	38	51	13
23	28	52	24
24	48	52	4
Mean Difference - Physics			14.292
Standard Deviation			9.295

were 24 students who took the pre-test and continued in the course all year and also took the post-test. Thus n=24 for both the pre-test and post-test. It should be noted that this group of students was taught physics by a high school Physics teacher and used traditional high school Physics curriculum.

Analysis of the t-test results described a significant difference between the pre-test and the post-test mean scores for the high school physics course. Table II illustrates the t-test results on the comparison of pre-and post-test scores recorded for students in the high school physics course. The group of 24 students had a mean pre-test score of 42.333 and a mean post-test score of 56.625. A t-test value of 7.533 was computed and this indicated that the score differences were to be significant at the .05 level (alpha = .000).

Table III presents the distribution of pre- and post- physics principles test scores recorded for students in the high school Principles of Technology course. Each student is identified by a number at the left margin of the table. The pre-test score, post-test score and difference (or gain) score for each student are listed to the right on the same row following the student's identification number. Pre-test scores ranged form 25.0 to 53.0. Post-test scores observed at the end of the school year for high school Principles of Technology ranged from 43.0 to 66.0. There was a mean increase of 14.1 points between pre-test and post-test for the high school Principles of Technology course with a standard deviation of 5.28. The number of students enrolled in the high

TABLE II

T-TEST COMPARISON OF PRE- AND POST-TEST SCORES RECORDED FOR STUDENTS IN HIGH SCHOOL PHYSICS

Pre-test (n=24) Mean S.D.	Post-test (n=24) Mean S.D.	t-value	p
42.333	56.625	7.533	.000
8.56	11.992		

TABLE III

DISTRIBUTION OF PRE- AND POST-TEST SCORES FOR STUDENTS ENROLLED IN HIGH SCHOOL PRINCIPLES OF TECHNOLOGY

Student ID. Number	Pre-test (n=10)	Post-test (n=10)	Difference
1	35	43	8
2	29	44	15
3	50	62	12
4	29	49	20
5	53	66	13
6	35	48	13
7	43	48	5
8	29	44	15
9	36	53	17
10	25	48	23
Mean Difference - PT			14.100
Standard Deviation			5.280

school Principles of Technology course fluctuated during the year, but there were ten students who took the pre-test and continued in the course all year and also took the post-test. Thus n=10 for both the pre-test and the post-test. It should be noted that this group of students was taught Principles of Technology by a high school Physics teacher who used the Principles of Technology curriculum developed by CORD (Center for Occupational Research and Development in Waco, Texas).

Table IV illustrates the t-test results on the comparison of pre- and post-test scores recorded for students in the high school Principles of Technology course. The t-test results showed a significant difference between the pre-test and the post-test mean scores for the high school Principles of Technology students. The group of ten students had a mean pre-test score of 36.40 and a mean post-test of 50.50. A t-test value of 8.445 was computed and indicated the differences were significant at the .05 level (alpha = .000).

The distribution of pre- and post- physics principles test scores recorded for students in the Principles of Agri-technology course are presented in Table V. Each student is identified by a number at the left margin of the table. The pre-test score, post-test score and difference (or gain) score for each student is listed left to right on the same row following the student's identification number. Pre-test scores ranged from 23.0 to 57.0. Post-test scores observed at the end of the school year for the Principles of Agri-technology course ranged from 27.0 to 68.0. There was a mean

TABLE IV

T-TEST COMPARISON OF PRE- AND POST-TEST SCORES RECORDED FOR STUDENTS IN PRINCIPLES OF TECHNOLOGY

Pre-test (n=10) S.D.	Post-test (n=10) S.D.	t-value	p
36.40	50.50	8.445	.000
9.442	7.75		

TABLE V

DISTRIBUTION OF PRE- AND POST-TEST SCORES FOR STUDENTS ENROLLED IN HIGH SCHOOL PRINCIPLES OF AGRI-TECHNOLOGY

Student ID. Number	Pre-test (n=9)	Post-test (n=9)	Difference
1	27	39	12
2	24	28	4
3	40	59	19
4	24	27	8
5	23	47	24
6	35	40	5
7	57	68	11
8	35	36	1
9	33	62	29
Mean Difference - PAT			12.000
Standard Deviation			9.987

increase of 12.0 points between pre-test and post-test for the Principles of Agri-technology course with a standard deviation of 9.987. The number of students enrolled in the Principles of Agri-technology course fluctuated during the year, but there were nine students who took the pre-test and continued in the course all year and also took the post-test. It should be noted that this group of students were taught Principles of Agri-technology by a high school Agricultural Education instructor (with a minor in Physics), and in a traditional agricultural education setting. The instructor used the Principles of Technology curriculum developed by CORD and was directed toward agricultural applications by the instructor.

The t-test results on the comparison of pre-test and post-test scores recorded for students in the Principles of Agri-technology course are illustrated in Table VI. The t-test showed a significant difference between the pre-test and the post-test mean scores for the Principles of Agri-technology course. The group of nine students had a mean pre-test score of 33.111 and a mean post-test score of 45.111. A t-test value of 3.605 was computed and the difference was found to be significant at the .05 level (alpha = .007).

Table VII was constructed to permit a comparison of means between pre-test/post-test differences (or gain) scores for students in high school Physics versus students in Principles of Agri-technology. The high school Physics course had a score difference mean of 14.292 points for 24 students, and had a standard deviation of 9.295. The Principles of Agri-technology course had a

TABLE VI

T-TEST COMPARISON OF PRE- AND POST-TEST SCORES RECORDED FOR STUDENTS IN PRINCIPLES OF AGRI-TECHNOLOGY

Pre-test (n=9) S.D.	Post-test (n=9) S.D.	t-value	p
33.111	45.111	3.605	.007
10.787	14.887		

TABLE VII

COMPARISON OF PRE-TEST/POST-TEST DIFFERENCE SCORES BETWEEN STUDENTS IN PHYSICS VERSUS PRINCIPLES OF AGRI-TECHNOLOGY

Physics Gain Score (n=24) S.D	PAT Gain Score (n=9) S.D.	t-value	p
14.292	12.000	.867	.411
9.295	9.987		

score difference mean of 12.0 points for nine students and had a standard deviation of 9.987. A t-test yielded a t-value of .867, which was not found to be significant at the .05 level (a table adapted from A. L. Sockloff and J. N. Edney, Some extension of Student's t and Pearson's r central distributions, Technical Report [May, 1972], Measurement and Research Center, Temple University, Philadelphia. A two-tailed t-test with 31 degrees of freedom is significant with a t-value less than -2.042 or greater than 2.042) (Bartz, 1988). Thus, there was no significant difference between pre-test/post-test gain scores for students in high school Physics versus students in Principles of Agri-technology.

A comparison of means between pre-test/post-test differences (or gain) scores for students in high school Principles of Technology versus students in Principles of Agri-technology is contained in Table VIII. The high school Principles of Technology course had a difference mean of 14.1 points for ten students, and had a standard deviation of 5.280. The Principles of Agri-technology course had a difference mean of 12.0 points for nine students, and had a standard deviation of 9.987. A t-test yielded a t-value of .295, which was found to be significant at the .05 level. (A table adapted from A. L. Sockloff and J. N. Edney, Some extension of Student's t and Pearson's r central distributions, Technical Report [May, 1972], Measurement and Research Center, Temple University, Philadelphia. A two-tailed t-test with 17 degrees of

TABLE VIII

COMPARISON OF PRE-TEST/POST-TEST DIFFERENCE SCORES
BETWEEN STUDENTS IN PRINCIPLES OF TECHNOLOGY
VERSUS PRINCIPLES OF AGRI-TECHNOLOGY

PT Gain Score (n=10) S.D.	PAT Gain Score (n=9) S.D.	t-value	p
14.100	12.000	.295	.776
5.280	9.987		

freedom is significant with a t-value less than -2.110 or greater than 2.110). Thus, there was no significant difference between pre-test/post-test gain scores for students in high school Principles of Technology versus students in Principles of Agri-technology.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

Each morning we wake up to new technological advances. While we sleep someone has found a different way to use new or existing technology. Technology or the application of principles of physics is one of the main factors affecting employability in the world today. Employers look for employees that are hard working and energetic, but more and more employers are looking for people who have a working knowledge of how and why things work the way they do. Jordan (1986) said while it is obvious that not everyone will become a technician, most students can benefit from an understanding of the basic principles of technology.

Traditionally, students planning to go into fields of study such as science and engineering requiring a college degree have taken high school physics courses. Students looking to go into the labor force or trade schools after high school graduation saw no advantage to taking so called hard courses, such as physics.

With more demand from the work place for students to have some form of technology background, alternatives to a high school physics course have been sought. One such alternative is the Principles of Agri-technology, an applied physics course being taught through selected Agricultural Education Departments in Oklahoma since the 1989-90 school year. After three years of implementing the Principles of Agri-technology it was deemed necessary to evaluate the course. We must ask the question: Can Principles of Agri-technology, an applied physics course taught in a traditional Agricultural Education program, be as beneficial and academically valid toward technological literacy to high school students as regular high school physics and technology courses?

Purpose

The purpose of this study was to evaluate physics and technological literacy performances of students enrolled in a high school Physics course, a high school Principles of Technology course, and a high school Principles of Agri-technology course by means of scores on a teacher constructed physics principles test.

Objectives

In order to achieve the purpose of this study, the following objectives were formulated.

1. To measure high school students' knowledge level of physics and technology at the beginning of the school year as determined by a pre-test.

2. To compare increases in students' knowledge of physics and technology as achieved through a high school Physics course, a high school Principles of Technology course, and a high school Principles of Agri-technology course, to be determined through

gain scores between pre-test and post-test.

3. To compare the pre-test and post-test scores on a physics principles test between the students enrolled in a high school Physics course versus a Principles of Agri-technology course.

4. To compare the gain scores on a physics principles test between the students enrolled in a high school Principles of Technology course versus Principles of Agri-technology.

Hypothesis Testing

Hypothesis testing was between pre-test and post-test scores for each of the three test groups. Since each student had a pre- and a post-test scores, a correlated t-test formula was used to test for significant difference between pre- and post-test scores. Hypothesis testing was also completed between gain scores of a high school Physics courses versus Principles of Agri-technology, and between gain scores of a high school Principles of Technology course versus Principles of Agri-technology. Since enrollment numbers varied for each of the test groups and variances were equal, a Separate Variance t-test was used to test for significant difference between mean gain scores.

The use of a t-test to determine significant differences in the analysis of data was explained by Popham (1973) as follows:

> The t-test is used to determine just how great the difference between two means must be for it to be judged significant, that is, a significant departure from differences, which might be expected by chance alone. Another way of stating the function of the t-test is to assert that, through it's use, we test the null hypothesis that two groups means are not significantly different, that is, the means are

> so similar that the same groups can be considered to have been drawn from the same population (pp. 124-125).

Scope of the Study

This study was conducted in two metropolitan high schools. The pre-test part of the study was given to one section of first year Physics and one section of first year of Principles of Agri-technology at the Norman High School, Norman, Oklahoma, and one section of first year Principles of Technology at the Putnam City High School in Oklahoma City, Oklahoma. The post-test portion of the study was given to the same three sections in the same two high schools. This study was conducted during the 1992-93 academic school year.

The total number of students participating in the study were as follows:

High School Physics	N = 24
Principles of Technology	N = 10
Principles of Agri-technology	N = 9

For students to be considered for the study they had to have taken the pre-test at the first of the school year, remained in the course all year, and have taken the post-test at the end of the academic school year.

Measuring Instruments

A 100 question test over physics and technology was used as a pre- and post-test for the three test physics classes. The test was approved by all three teachers whose classes were involved in the study.

The test material was taken from over 300 unit test questions found in the Principles of Technology curriculum, and the high school physics instructor allowed no question that was not covered by his traditional curriculum. The topics for questions and number of questions for each topic were as follows:

Unit 1.	Force	15 questions
Unit 2.	Work	15 questions
Unit 3.	Rate	15 questions
Unit 4.	Resistance	15 questions
Unit 5.	Energy	15 questions
Unit 6.	Power	15 questions
Unit 7.	Force Transformers	10 questions

The number of questions was reduced for Unit 7, Force Transformers, because it may not be covered during the first year of PT and PAT classes due to allocation of time.

Questions varied in level of difficulty. Some questions were multiple choice, fill in the blank, true or false, and some math problems were on the test.

Measurement Procedures

The pre-tests were given to all of the three test groups on the fifteenth day of class. This time was chosen because the classes would be well constructed at this time. Drop and adds to class should have been complete, and instructors would have students into their daily routines. No class had prior to enrollment knowledge that they would be part of a test group, so the classes were made up of students who randomly enrolled in those classes. No grouping had been made as far as test scores, gender, race, color, creed, age, or national origin.

The same test used for the pre-test was used for the post-test. The post-test was given to the three test groups towards the end of the school year. Only those students who took both the pre-test and the post-test were used in the analysis.

Analysis Procedures

This study compared three groups of high school students enrolled in physics related courses. One group was a traditional physics class, one group was a Principles of Technology class using the Principles of Technology (CORD) curriculum, and one group was a Principles of Agri-technology class using the Principles of Technology (CORD) curriculum directed toward agriculture by the agriculture education instructor.

The quantitative comparison of the students was done from their pre- and post-test difference scores. Two comparisons were made, one between a high school Physics courses versus Principles of Agri-technology and the other between a Principles of Agri-technology course versus Principles of Technology, thus the t-test was used to test for significant differences between the groups. The significant level of .05 was used as the level for acceptance or rejection of each of the formulated null hypotheses. The formula used for comparison of the t-test is shown in Appendix D.

Summary of the Findings

The purpose of this section of the chapter is to provide a summary of the findings of the study as they relate to the objectives set forth at its inception.

Hypothesis 1 - There is no significant difference between the pre- and post-test scores of students enrolled in the high school Physics course. There was a significant difference between the pre- and post-test scores of students enrolled in the high school Physics course, therefore Hypothesis 1 was rejected.

Hypothesis 2 - There is no significant difference between the pre- and post-test scores of students enrolled in the high school Principles of Technology course. There was a significant difference between the pre- and post-test scores of students enrolled in the Principles of Technology course, therefore Hypothesis 2 was rejected.

Hypothesis 3 - There is no significant difference between the pre-and post-test scores of students enrolled in the Principles of Agri-technology course. There was a significant difference between the pre- and post-test scores of students enrolled in the Principles of Agri-technology course, therefore Hypothesis 3 was rejected.

Hypothesis 4 - There is no significant difference between the pre-test/post-test difference scores for students enrolled in the high school Physics course versus students enrolled in the

Principles of Agri-technology course. There was a small difference between the gain scores, but the difference was not great enough to show statistical significance, therefore Hypothesis 4 failed to be rejected.

Hypothesis 5 - There is no significant difference between the pre-test/post-test difference scores for students enrolled in the Principles of Technology course versus students enrolled in the Principles of Agri-technology course. There was a small difference between the gain scores, but the difference was not great enough to show statistical significance, therefore Hypothesis 5 failed to be rejected.

To have an overview of the findings of the study, summary tables have been compiled. Summary Table IX gives a recap of the three test groups as to numbers in the samples, pre-test means, post-test means, difference means, standard deviations between the pre- and post-test scores, and the t-values computed between the pre- and post-means for each class. The t-values for each class were as follows:

High School Physics	= 7.533
Principles of Technology	= 8.445
Principles of Agri-technology	= 3.605

All t-values were found to be significant at the .05 level.

Summary Table X shows t-test scores for comparisons of gain scores between Principles of Agri-technology and both high school Physics and the Principles of Technology course. A t-value of .867 was computed between gain scores of PAT versus high school Physics and a t-value of .295 was computed between gain scores of PAT and the

TABLE IX

SUMMARY COMPARISONS OF PRE- AND POST-TEST SCORES
FOR THE THREE TEST GROUPS

Group Name	Pre-test Mean	Post-test Mean	Difference Mean	Standard Deviation	T-value
H. S. Physics (n=24)	42.333	56.625	14.292	9.295	7.533
Principles of Technology (n=10)	36.400	50.500	14.100	5.280	8.445
Principles of Agri-technology (n=9)	33.111	45.111	12.000	9.987	3.605

TABLE X

SUMMARY COMPARISONS OF GAIN SCORES FOR STUDENTS ENROLLED IN
PRINCIPLES OF AGRI-TECHNOLOGY VERSUS H.S. PHYSICS AND
PRINCIPLES OF TECHNOLOGY

Group Name	n	Mean Difference	Standard Deviation	t-Value	P
Principles of Agri-technology	9	12.000	9.987	.867	.411
H. S. Physics	24	14.292	9.295		
Principles of Agri-technology	9	12.00	9.987	.295	.776
Principles of Technology	10	14.100	5.280		

Principles of Technology course. Both t-values were found not to be significant at the .05 level of significance.

Conclusions

The purpose of this section is to provide conclusions based on the findings of this study, and to further explain acceptance or non-acceptance of the hypotheses in this study. It was concluded that:

1. Since there were significant differences between the pre- and post-test scores for all three test classes it is concluded that students in all three classes made significant gains in technological and physics literacy knowledge regardless of the curriculum used, teaching style or atmosphere of the classroom.

2. Since there were no significant differences between gain scores of students enrolled in the high school Physics course versus the Principles of Agri-technology it is concluded that students' ability to learn physics principles were not affected either negatively or positively by differences noted in the two classes.

3. Since there were no significant differences between gain scores of students enrolled in the Principles of Technology course versus the Principles of Agri-technology course it is concluded that the Principles of Technology curriculum, whether taught in a technology setting or in an agriculture education setting, had no affect either negatively or positively on the amount of physics principles learned by PT or PAT students.

4. Since there were no significant differences between gain scores of students enrolled in the high school Physics course versus students in the Principles of Agri-technology course, nor were there any significant differences between gain scores of students enrolled in the Principles of Technology versus the Principles of Agri-technology course, it is concluded that the Principles of Agri-technology course was just as valid for teaching physics principles as the Principles of Technology course and the high school Physics course.

Recommendations

The purpose of this section is to provide some recommendations concerning the outcomes of this study. It is recommended that:

1. Because no student learning differences were found among a high school Physics course, a high school Principles of Technology course or a Principles of Agri-technology course, high school students should be offered classes in Principles of Technology and Principles of Agri-technology (where applicable), as an alternative to traditional Physics. Many so called average students that would not normally take a physics course would be afforded classes that would teach them very useful physics principles. These average students probably would never enroll in a traditional physics class, thus making the PT and PAT courses available to many students would increase greatly the number of students learning physics.

2. Since all three test groups made significant gains in physics principles, and since there were no significant differences

in the gain scores between the high school Physics course and the Principles of Agri-technology course, and further there were no significant differences in gain scores between the Principles of Technology course and the Principles of Agri-technology course, students should be allowed to use Principles of Agri-technology as a physics credit to meet high school graduation requirements.

3. Since all three test groups made significant gains in physics principles, and since there were no significant differences in the gain scores between the high school Physics course and the Principles of Agri-technology course, and further there was no significant difference in gain scores between the Principles of Technology course and the Principles of Agri-technology course, students should be allowed to use Principles of Agri-technology as a Physics requirement to meet college entrance requirements.

4. More Agricultural Education Departments implement Principles of Agri-technology courses into their programs to better prepare agricultural students for a job force needing technological knowledge.

5. Teachers be given in-service training to help them implement technological principles into their classrooms.

6. Other non-traditional more academic, agricultural related courses be introduced into Agricultural Education programs.

Recommendations for Further Research

The purpose for this section is to identify further research needed in this study area. Recommendations for further research are:

1. Similar studies be conducted on a broader scale.

2. Similar studies be conducted in different size school systems.

3. Studies be conducted on implementing part of Principles of Technology curriculum into regular Agricultural Education classes.

4. Studies to be conducted comparing other courses taught in Ag-Ed classes, versus similar courses being taught in vo-tech classes or other high school classes such as Horticulture or Ag-mechanics.

5. Follow-up studies be conducted involving students who were taught Principles of Agri-technology compared to students in other physics related courses, as far as job placement and job retention.

6. Further research be conducted to find administrators' views of Principles of Agri-technology as an alternative to high school physics.

7. Further research be conducted to find Ag-Ed teachers' views on teaching non-traditional agriculture classes.

Implications

Today high school students need as much science under their belts as is possible. If students are not allowed options in curriculum that offer different levels and different learning atmospheres, especially in the science areas many students will not be motivated to pursue these learning opportunities.

Literature cited in this study showed that there is a need for more Physics and technological literacy among all high school graduates. Any course which will help students acquire these literacies should be made available to all students if at all possible.

While the gain scores for the three test groups showed no significant differences in students' learning of physics principles, no matter in which physics related course they were enrolled, it should be noted that many of the students that enrolled in the Principles of Agri-technology course would not have enrolled in a traditional physics course. Several students, and in small rural schools, a large percentage of the school population feel more comfortable in an easy going atmosphere, such as is found in the agriculture building. If students feel more comfortable, and learning takes places, why should not more, academically challenging courses be taught.

The Principles of Agri-technology course was a brave step taken by the Oklahoma Department of Vocational-Technical Education. The Principles of Agri-technology works as an alternative to both a traditional Agricultural Education class, and to a more academically structured science or physics class.

The findings of the study show that the students enrolled in the Principles of Agri-technology course learned as much about physics principles as did the students enrolled in a high school Physics course and/or students in a Principles of Technology course and therefore it should be considered as a valid substitution for traditional high school Physics.

In the opinion of the researcher, Principles of Agri-technology helps meet the needs of high school students, especially agricultural oriented students, in the principles of physics areas that will make them a successful and employable asset for today's society.

As we re-examine the question, (The Course, Principles of Agri-technology, Physics or Farce?) the only realistic and acceptable answer is that the course, Principles of Agri-technology is physics.

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APPENDIXES

APPENDIX A

OKLAHOMA STATE UNIVERSITY INSTITUTIONAL REVIEW

BOARD FOR HUMAN SUBJECT RESEARCH

OKLAHOMA STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD
FOR HUMAN SUBJECTS RESEARCH

Date: 1-12-93 **IRB#:** AG-93-011

Proposal Title: THE COURSE, "PRINCIPLES OF AGRICULTURAL TECHNOLOGY", PHYSICS OR FARCE?

Principal Investigator(s): James P. Key, Tony Christian

Reviewed and Processed as: Exempt

Approval Status Recommended by Reviewer(s): Approved

APPROVAL STATUS PERIOD VALID FOR ONE CALENDAR YEAR AFTER WHICH A CONTINUATION OR RENEWAL REQUEST IS REQUIRED TO BE SUBMITTED FOR BOARD APPROVAL. ANY MODIFICATIONS TO APPROVED PROJECT MUST ALSO BE SUBMITTED FOR APPROVAL.

Comments, Modifications/Conditions for Approval or Reasons for Deferral or Disapproval are as follows:

Signature: Marcia L. Tilley
Chair of Institutional Review Board

Date: January 15, 1993

APPENDIX B

TEACHER CONSTRUCTED PHYSICS

PRINCIPLES TEST

PRINCIPLES OF TECHNOLOGY TEST

Name ______________________________ Score ______________

______ 1. When we use the english system of units, mechanical force is measured in pounds. When we use metric (or SI) units, mechanical force is measured in

a. Newtons
b. Newtons per square meter (N/M^2)
c. Pounds (lb)
d. Pounds per square food (lb/ft^2)

2. When two forces of different magnitude act on an object in opposite directions, the object is in (a balanced, an unbalanced) condition. (Choose the correct answer.)

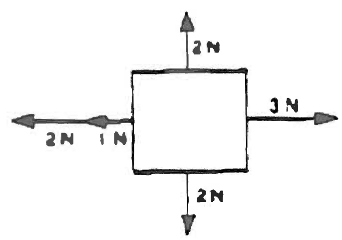
3. A net force of zero means that all forces acting on an object create (a balanced, an unbalanced) condition. (Choose the correct answer.)

In the following five questions, match the words with their correct definitions. In the space provided, fill in the letter of the definition that corresponds to the numbered word.

______ 4. Vector
______ 5. Scalar
______ 6. Mass
______ 7. Weight
______ 8. Torque

a. A measure of the amount of matter contained in an object.
b. A physical quantity described by both magnitude and direction.
c. A physical quantity described only by magnitude.
d. A measure of gravitational pull.
e. The product (result) of the force applied times the length of the lever arm.

9. Is the block in the following diagram in equilibrium? Explain your answer.



_____10. Pressure in fluid systems is defined as

a. Force times the area upon which the force acts
b. Force divided by the area upon which the force acts
c. Force times the volume of the fluid
d. Force divided by the volume of the fluid

_____11. A torque wrench has a lever arm that's 18 inches long. A force of 20 pounds is applied to the end of the wrench to tighten a bolt. The torque applied is

a. 40 lb·ft
b. 30 lb·ft
c. 360 lb·ft
d. 100 lb·ft

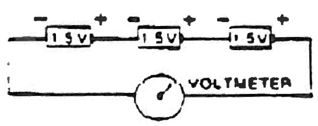
_____12. _____ is the most common source of DC voltage.

a. A DC battery
b. A home wall-socket
c. A toaster
d. A 200-volt outlet

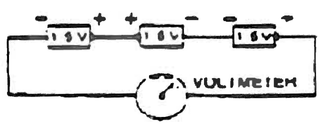
_____13. Voltage can be thought of as a forcelike quantity because it

a. Moves electrons through a circuit
b. Moves conductors in circuits
c. Is found in electrical circuits
d. Requires insulation on conductors in circuits

14. Give the voltage that would be registered by a voltmeter for each of the following circuits.



V = _____ Circuit A



V = _____ Circuit B

_____15. Temperature

a. Is a scalar quantity
b. Is a measure of molecular motion
c. Depends on the presence or absence of heat energy
d. All of the above

16. According to the technical definition of work, work in a mechanical system is done only when ______________________. (Complete the statement.)

______17. The unit of mechanical work in the English system is the ______. (Choose the correct answer.)

a. N·m
b. Volt-coulomb
c. ft·lb
d. N/m

18. From the technical definition of work, explain why a man ***holding*** a suitcase 1 ft. above the floor *is not* doing work.

19. Ten joules of work is also equal to ______________________ N·m of work. (Complete the statement)

______20. In calculating the work done by an applied force that moves an object, the distance the object moves is measured: (Choose a or b)

a. Only while the force is applied to the object.
b. As long as the object continues to move.

21. If an angle of 360° is equal to an angle of 6.28 radians (2π radians), what angle in radians is 90° equal to?

22. How much work is done when a load is moved 10 meters by a 50-newton force?

23. A wrench with an 18-in. handle turns through an angle of 2.3 radians while a force of 50 lb. is applied to the end of the handle. Find the work done.

24. The fuel system on an automobile is said to be an open fluid system. The automobile brake system is said to be (an open, a closed) fluid system. (Choose the correct words)

25. The most common unit so ***electrical work*** is the ______________________. (Complete the statement)

26. The forcelike quantity in the equation for electrical work is ______________________. (Complete the statement)

27. One coulomb of charge times 1 volt is equal to one ____________________. (Complete the statement)

28. Electrical efficiency of 100 percent would mean that the output work is ______________________. (Complete the statement)

29. Electrical current (I) is a rate. It is equal to the amount of electrical charge moved (divided, multiplied) by the time to move the charge. (Choose the correct word)

30. The unifying equation for work is: Work equals a ___________ quantity times a ___________ quantity. (Fill in the blanks)

31. In the unifying equation for ***rate***, the ***displacementlike quantity*** is (multiplied, divided) by elapsed time.

32. Linear mechanical speed is usually expressed in ft/sec or mi/hr in English units and in _____ in SI units.

33. When a linear speed increases during an elapsed time, the increase is described as _________________.

34. Angular mechanical speed is measured in _________________ per second.

35. A box placed on a conveyor moving at constant speed travels 50 feet in two minutes. What is the speed of the box (and the conveyor) in ft/sec?

36. The rotating blue light of a police car rotates through 942 radians in five minutes. Find the angular speed of the light in revolutions per minute (rpm).

37. When the power switch is turned off, a motor shaft rotating at 30 rev/sec comes to a complete stop (zero rev/sec) in 60 seconds. Find the shaft deceleration in rev/sec^2.

______38. An angular speed of four rev/min is equal to an angular speed of ______ rad/sec. (Use the relationships 1 revolution = 6.28 radians and 1 minute = 60 seconds to help you select the correct answer from the choices given below.)

a. 0.210 rad/sec
b. o.418 rad/sec
c. 0.636 rad/se
d. 1.272 rad/sec

39. Kilograms and grams are units of mass. Gallons and liters are units of _________________.

40. Find the steady flow rate of water in a pipe if it sprays 300 ft^3 of water on a pasture in four hours. Give the answer in ft^3/min.

41. A window air conditioner is charged with 3 kg of Freon gas. Find the time it takes to circulate the entire 3 kg of gas through the air conditioner if the mass-flow rate of the gas is 0.75 kg/min.

42. Electrical flow rate is expressed as the amount of electrical charge moved (multiplied, divided) by elapsed time.

43. The unit of measurement for electrical flow rate is _________________.

44. One ampere is equal to (one coulomb per second, one coulomb·second).

45. Heat always flows from a (warm, cool) region to a (warm, cool) region.

46. Streamlining is one way to reduce (drag force, speed) on an object moving through a fluid. (Choose the correct term)

47. The force of dry friction depends on the nature of the two surfaces in contact, and _________________. (Complete the sentence)

48. It takes more force to start a box sliding than to keep it sliding on a level floor because ___________. (Complete the sentence)

49. Kinetic friction is always (less than, greater than) static friction. (Choose the correct term)

50. A plastic box weighing 100 lb will initially start to slide on a level metal truck bed when a push of 50 lb is applied. What is the coefficient of static friction for plastic on metal? (Show your work)

51. Fluid resistance in a pipe can be decreased by (increasing, decreasing) the pipe's cross-sectional area. (Choose the correct word)

52. Name three factors that determine the resistance of a wire.

53. What is the resistance of a circuit that has a voltage difference of 100V and a current of 5A through the circuit? (Show your work)

54. What is the total resistance across two resistors in parallel if their values are 4 ohms and 8 ohms? (Show your work)

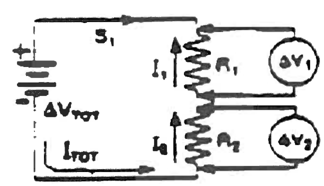
55. In Problem 23, what is the current flowing our of a 12-volt battery placed in the circuit when the two resistors are connected in parallel across the battery? (Show your work)

56. Copper wire is classified as an electrical (conductor, semiconductor, insulator) while glass is classified as an electrical (conductor, semiconductor, insulator). (Choose the correct word in each case)

57. Electrical resistance opposes (flow of charge, flow of heat) in electrical systems. (Choose the correct word or words)

58. Use the diagram shown her to find the quantities below, when >V_{TOT} = 80 V, $R_1 = 4\mho$ and $R_2 = 4\mho$

a. R_{TOT} = ______
b. I_{TOT} = ______
c. I_1 = ______
d. ΔV_1 = ______
e. I_2 = ______
f. ΔV_2 = ______



59. Thermal resistance is the opposition to flow of ________________. (Complete the sentence)

60. Thermal conductivity for a particular material depends on the (type, thickness) of the material. (Choose the correct word)

61. Word done divided by time to do the work is the basic definition of ________________.

62. Electrical power is equal to the electrical work done (multiplied by, divided by) the time to do the work.

______63. Use Ohm's law $R = \Delta V/I$, to change the power equation, $P = (\Delta V) \times I$, to:

a. $P = I^2R$
b. $P = (\Delta V)^2/R$

64. The kilowatt-hour (kWh) is a unit of (energy, power, resistance).

65. An electric toaster is rated at 110 volts and 9.09 amperes. What is the electric power used by the toaster?

66. The rated power of a lamp bulb is 60 watts. What is the current in amperes when the bulb is operating on 110 volts?

______67. When one thousand newton-meters of work are done, the power used (Select the correct answer)

a. Depends only on the force applied while the work is done
b. Depends on the time it takes to get the work done
c. Is the same no matter how long it takes

68. The kilowatt-hour (kWh) (is, isn't) a unit of power.

69. Each of the follow—N·m/sec, ft·lb/sec, J/sec, and watt—is a unit of (energy, work, power).

70. A crane lifts an 1800-pound beam upward a distance of 10 feet at constant speed. This work is done in six seconds. Find:

a. The work done in units of ft·lb.
b. The power required in ft·lb/sec.

71. A crane lifts a 3600-pound beam upward a distance of 10 feet at constant speed. This work is done in 12 seconds.

a. The weight of the beam is double the weight of the beam in Problem 9. Is the work done doubled? (Show your work)
b. The weight of the beam is double the weight of the beam in Problem 9. The time to lift the beam is double the time in Problem 9? Is the power doubled? (Show your work)

______72. A force of 25 newtons is needed to keep a piston moving at a speed of 0.5 meter per second. The power of the piston is (Select the correct answer)

a. 12.5 watts
b. 25.0 joules/second
c. 50.0 horsepower
d. 25.0 newton·meters/second

73. Efficiency of a machine can be defined as ***output power*** (multiplied, divided) by ***input power***.

74. What is the efficiency of a machine that raises a box weighing 900 newtons a distance of one meter in one second, while requiring 1000 watts of input power?

75. A water pump develops power to move water up from a lake to a water tank. Pump power can be found if your know the weight of water raised, the height the water is raised, and ________________.

76. Energy is defined as the ability to do________________. (Complete the sentence)

77. When a mechanical, fluid, electrical, or thermal system has energy, the energy is often used by the system to do useful ________________. (Complete the sentence)

Select the items in Column B to complete the statements given in Column A.

	Column A	Column B
______78.	Is energy stored for later use.	a. Potential energy
______79.	Is energy of motion.	b. Kinetic energy
______80.	Often changes when a body's position or shape changes.	c. Conservation of energy
______81.	Is present in a stretched spring that is not moving.	
______82.	Implies that the total energy of a system is constant, if all forms of energy are considered.	
______83.	Increases when a body's speed increases.	

Match the statements given in Column A with those in Column B. Write the letter that represents your choice from Column B.

	Column A	Column B
______84.	A flywheel that is spinning	a. Gravitational potential energy
______85.	A stretched, stationary auto brake spring	b. Elastic potential energy
______86.	A pendulum at the very bottom of its swing	c. Kinetic energy (translational)
______87.	Water stored behind a dam	d. Kinetic energy (rotational)

88. The "mechanical equivalent of heat" is a mathematical relationship between units of mechanical energy and units of ________________.

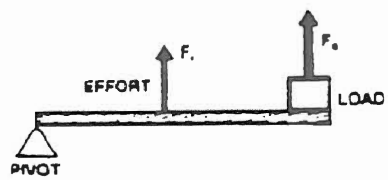
89. A steel ball has a mass of 2kg and loses 300 C of temperature when dropped into a tank of water. How much heat is transferred to the water if the specific heat of steel os 0.11 k al/(kg·C°)?

90. Heat energy is transferred by three processes. They are convection, ________________ and ________________.

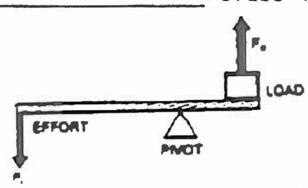
91. Force transformers are a class of machines and devices in mechanical, fluid, and electrical energy systems that change (input, output) values of "force," movement or rate into different (input, output) values.

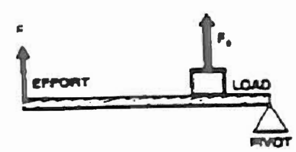
92. When output work equals input work in a force transformer, the force transformer (has lost energy through friction, is 100 percent efficient).

Each of the three drawings below shows an effort, a load, and a pivot for a lever. Complete the sentence below each drawing to correctly identify the class of lever being shown.



93. An arm is a ________________-class lever.





94. A crowbar is a ________________-class lever.

95. A wheelbarrow is a ________________-class lever.

96. A mechanical force transformer has an efficiency equal to the ratio of the (Work Out/Work In, Work In/Work Out) times 100 percent.

97. When 200 ft·lb of input work is done on a *frictionless*, block and tackle, the lifting force on the load raises the load six inches (0.5 foot). What is the amount of lifting force on the load?

98. From a count of the number of cables that support a load, the ideal mechanical advantage (IMA) of a block-and-tackle force transformer is found to be equal to two. When the 40,000-lb load is actually lifted, it requires 22,000 lb of input force. The efficiency of the block and tackle is about ________________.

(Hint: Remember that $EIT = \frac{AMA}{IMA} \times 100\%$, where $AMA = F/F$)

99. A chain hoist with an 8-inch diameter input wheel and a 2-inch diameter output or load wheel operates without internal friction (100% efficient). Find the actual mechanical advantage of the chain hoist. (IMA and AMA for wheel and axle force transformers are:

$$IMA = \frac{\text{input radius}}{\text{output radius}} \text{ and } AMA = \frac{\text{output force}}{\text{input force}}$$

100. An overhead-crane hoist was designed with an IMA of 10 when rigged as specified. Internal friction reduces the efficiency to 80%. Find the load that the crane will lift when the input force on the line is 15 tons. (See "Hint" in Problem 98).

APPENDIX C

PHYSICS I LEARNER OUTCOMES

PHYSICS

Physics, as a two-semester high school course, should provide a basic understanding of the physical laws fundamental to all sciences. Adequate mathematics preparation is strongly recommended as a prerequisite. Laboratory activities are recommended because science is an investigative process.

The Suggested Learner Outcomes are to be used as a guide. The teacher should use discretion as to which areas to cover depending on the interests and abilities of the students. To quote Sire Isaac Newton, "It is better to achieve a little with certainty than a great deal that one is not sure of."

PHI.1 The student will know and use the International System of Measurements.
Descriptive Statement: The student will use metric units in calculations and understand the derivation of other metric units.

PHI.2 The student will demonstrate safe and appropriate use of laboratory techniques and equipment.
Descriptive Statement: The student will follow safe procedures in the use of lab equipment.

PHI.3 The student will demonstrate utilization of instruments to measure physical quantities.
Descriptive Statement: The student will use instruments such as meter sticks, balances, spring scales, timers, thermometers, ammeters, and voltemeters to measure quantities. The student will be able to determine the significant digits of those measurements.

PHI.4 The student will conduct, collect, analyze, and interpret results of laboratory exercises.
Descriptive Statement: The student will:
a. assemble the apparatus;
b. collect the data;
c. analyze the data;
d. construct graphs from the data if needed;
e. interpret the physical relationship from the graph or data;
f. report conclusions.

PHI.5 The student will solve problems in physics through the use of mathematics.
Descriptive Statement: The mathematical skills developed will include:
a. solving equations with one unknown quantity;
b. the use of significant digits and scientific notation;
c. be able to interpret word problems and apply the correct formulas.

PHI.6 The student will understand the differences between scalar and vector quantities and solve problems involving those quantities.
Descriptive Statement: The student will use trigonometry and/or graphs to solve vector problems by finding the resultant of at least two vectors and resolving vectors into perpendicular components.

PHI.7 The student will gain an understanding of motion and Newton's laws of motions.
Descriptive Statement: The student will solve problems and understand the relationships of speed, acceleration, time, and distance. The student will know Newton's three laws of motion.

PHI.8 The student will gain an understanding and describe mathematically the conservation of energy, matter and momentum.
Descriptive Statement: The student will learn the relationship of kinetc energy and potential energy, and elastic and inelastic collision. The student will also be able to demonstrate the transfer of heat from one system to another.

PHI.9 The student will gain an understanding of the relationship between work, power, and energy.
Descriptive Statement: Through use of formulas and laboratory experiments, the student will learn the relationships of work, power, and energy.

PHI.10 The student will identify models of transverse and longitudinal waves and apply these to the interpretation of wave phenomena.
Descriptive Statement: The student will identify such phenomena as period, wavelength, frequency, amplitude, phase, reflection, refraction, diffusion, diffraction, interference, and Doppler effect.

PHI.11 The student will identify the main segments of the electromagnetic spectrum, emphasized the properties of light.
Descriptive Statement: The segments of the electromagnetic spectrum including radiowaves, microwaves, Gamma rays, infrared radiation, ultraviolet radiation, and visible light should be described in terms of frequency and wavelength. Major applications should be discussed.

PHI.12 The student will observe and describe the fundamental processes of reflection, refraction, and image formation.
Descriptive Statement: The student will understand the laws of reflection and refraction. The student will be able to identify the type, size, and position of images formed by plane mirrors, concave and convex mirrors, and converging and diverging lenses.

PHI.13 The student will study electrical charges and the interactive forces between them.
Descriptive Statement: The student will understand positive and negative charges, as well as electrical potential energy field between like and unlike charges.

PHI.14 The student will gain an understanding of electric currents.
Descriptive Statement: The concepts involved should include a description of electric units, circuits, energy, and Ohm's law.

PHI.15 The student will be able to describe properties of permanent magnets, electromagnets and their magnetic fields.
Descriptive Statement: These properties and fields might include bar magnets, horseshoe magnets, current-bearing wire, electric coil and electric motors.

*PHI.16 The student will be able to diagram and construct simple electrical circuits and apply Ohm's and Kirchhoff's laws.
Descriptive Statement: Circuits included should be series, parallel, and combined series-parallel.

PHI.17 The student will investigate the relationship of pressure and temperature to the volume of gases.
Descriptive Statement: Investigation of behavior of gases should include Boyle's, Charles's, and combined gas laws.

***PHI.18** The student will demonstrate a basic understanding of the concepts of the nucleus, nuclear reactions, and recent developments in use and research of nuclear energy.
Descriptive Statement: The student will be able to diagram a nuclear reaction, discuss transmutation, radioactivity, and half-life. Nuclear fission and fusion should be investigated. Modern use of nuclear energy as well as future use should be investigated.

PHI.19 The student will develop an interest in physics.
Descriptive Statement: A list of resource personnel, field trip locations, etc. should be compiled and utilized to stimulate student interest.

PHI.20 The student will demonstrate knowledge of how modern technology applies basic processes and skills for an improved standard of living.
Descriptive Statement: The student will investigate careers and professional opportunities that utilize scientific knowledge and technology.

APPENDIX D

STATISTICS APPLIED

The following "t" formulas were applied to the data for analysis:

Pre-test and post-test comparisons used a Pooled Variance Formula:

$$t = \frac{\overline{X}_1 - \overline{X}_2}{\sqrt{\left[\frac{\Sigma (X_1 - \overline{X}_1)^2 + \Sigma (X_2 - \overline{X}_2)^2}{N_1 + N_2 - 2}\right]\left[\frac{1}{N_1} + \frac{1}{N_2}\right]}}$$

Comparisons of Pre-test/Post-test difference scores between classes used a Separate Variance Formula:

$$t = \frac{\overline{X}_1 - \overline{X}_2}{\sqrt{\frac{S_1^2}{N_1} + \frac{S_2^2}{N_2}}}$$

VITA

Anthony Wayne Christian

Candidate for the Degree of

Master of Science

Thesis: THE COURSE, "PRINCIPLES OF AGRICULTURAL TECHNOLOGY," PHYSICS OR FARCE?

Major Field: Agricultural Education

Biographical:

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Professional Experience: Vocational Agriculture teacher at Norman, Oklahoma, July 1, 1979 to present.