

Impact of an Introductory Agriscience Technology Course in Developing Applied Skills Using Information Technologies

Dr. Kirk A. Swortzel
Dr. Jacquelyn P. Deeds
Dr. Walter N. Taylor
Mississippi State University

Abstract

The purpose of this study was to determine if students in an Agricultural and Environmental Science and Technology (AEST) program developed more skill using information technology after being enrolled in an introductory agriscience technology course. Furthermore, this study sought to determine if students who were enrolled in either a biology or business course developed more skill using information technology after being enrolled in their respective course. The population for the study consisted of 1,312 secondary students enrolled 14 AEST programs and 14 Biology/Business programs from all geographical areas of the state. By the end of the school year, students had more skill using e-mail, preparing a spreadsheet, preparing a multimedia presentation, preparing a graphic design, using a digital camera, using a Global Positioning System, making a purchase using the Internet, using a scanner, operating a CD burner, and troubleshooting/accessing technical help. More specifically, AEST students also had more skill at the end of the year using educational software and installing new programs on a computer. It is unclear as to whether being enrolled in a course using information technologies on a daily basis actually helps students become more skilled with information technologies. Because many of the skills used in this study were commonplace, additional research needs to be conducted to identify appropriate information technology skills as it relates to agriculture.

Note: This paper is based on the work supported by the National Science Foundation Information Technology Workforce Project #0089970.

Introduction and Conceptual Framework

Information Technology (IT) is a concept describing all aspects of managing and processing information. Specifically, information technology can be defined as the “study, design, development, implementation, support or management of computer-based information systems, particularly software applications and computer hardware” (Office of Technology Policy, n.d., p. 5). IT careers are based on computer technologies, the Internet, and networks concerned with creating, analyzing and accessing data for decision-making and problem solving. Information tools, such as personal computers and the Internet, are increasingly critical to economic success and personal advancement. Many IT workers design, develop, support and/or manage IT systems found in careers related to agriculture. These applications range from record keeping to making management decisions about fertilizer and pesticide applications, developing livestock breeding programs and using Global Positioning Systems (GPS).

Information Technology Application Skills

The U. S. Department of Education developed the National Educational Technology Plan *eLearning: Putting a World-Class Education at the Fingertips of All Children* (Rivero, 2000). The plan’s goals included providing all students and teachers with access to information technology in the classroom, schools, communities and homes. This report also indicated that all students will have technology and information literacy skills. However, many communities face a number of challenges to becoming savvy with information technologies.

The Office of Technology Policy (OTP) identified factors affecting the supply and quality of IT workers, which included a poor image of the IT profession, lack of career information and encouragement for students, a need for increased competency in math and science, challenges in the IT teaching infrastructure, and a failure to attract underrepresented groups to the IT profession (Meares & Sargent, 1999). The OTP report encouraged educators to provide K-12 students with information about science and technology careers, their rewards, and what education and training are necessary to pursue them (Meares & Sargent, 1999). Agricultural and Environmental Science and Technology (AEST) programs—IT based curricula—are attempting to foster students’ IT career path decisions as they relate to using information and computer technologies for today’s food and fiber production. At the core of this issue is determining the IT perspectives of secondary students concerning their perceived level of applied information technology skills.

Information technology research has shown that a complex pattern of factors affect a student’s performance, learning, and motivation in the classroom (Naughton, 1986). These factors include the subject matter being learned, instructional design concepts to include methods and techniques, information technology equipment and tools available, and contextual locations for learning. Furthermore, Atkinson (1999) indicated that the relationships between these complex factors and those attributes that students bring with

them, such as curriculum experience, knowledge base and personal goals, cannot be underestimated.

The application of information technology skills has progressed beyond drill and practice software (Kosakowski, 1998). Students must be actively involved in learning and work cooperatively on projects that integrate technology. When asked what skills do you think are necessary for an information technology career, keyboarding and computer skills and programming are the overwhelming choice of both boys and girls (Gupta & Houtz, 2000). Possessing good math skills rated near the bottom of the list.

Information Technology Skills Needed by IT Workers

The Assessment and Qualifications Alliance (2002) identified four different levels of information technology skills needed by IT workers. Level 1 skills included such things as finding and selecting relevant information, using different formats to help find and select relevant information, and presenting information in an accurate and clear manner. Level 2 skills included such things as identifying information from suitable sources, conducting effective searches for information, and selecting information relevant to your purpose (educational or occupational). Examples of Level 3 skills needed by IT workers included making judgments regarding the relevance and quality of information selected, using effective methods to exchange information to support your purpose, and presenting information in a format and style that suits your purpose and audience. The last level, Level 4, wants individuals developing strategies for using IT skills over a long period of time, monitoring their progress and adapting their strategy to achieve quality outcomes, and evaluating your overall strategy as it related to the outcomes of your work. The Assessment and Qualifications Alliance recommended that individuals create and submit a portfolio to document evidence of having successfully met the requirements to possess information technology skills.

Agricultural and Environmental Science and Technology Programs

AEST is an educational program that introduces students to new technologies and instructional areas leading to careers in related industries. The AEST curriculum is designed to provide students with a knowledge base in areas such as agricultural production, food processing, plant genetics, environmental stewardship, and international trade. Each subject matter area is supported by a variety of information technologies required for accessing, analyzing, and problem solving. For example, the *Concepts of Agriscience Technology* course introduces students to the sciences, technologies, and applied practices of the progressive agriculture/ agriscience industry. Emphasis is on an active learning environment enriched with technology and science based applications. The course serves as the entry-level course for the other courses in the AEST curriculum. The course consists of 13 units taught using computer modules and activities. Students use the computers for obtaining instructional content, journaling, accessing World Wide Web sources, and submitting unit

evaluations. Computers are used daily as an integral component of the instructional program. Each unit explores current and emerging trends, technologies, and career opportunities associated with that unit. These programs are located in all areas of the state, both urban and rural areas, and have a significant percentage of females and minority students enrolled in the courses.

School programs and relevant courses in these programs have to assume the responsibility of making sure students have the requisite information technology skills needed to enter and succeed in the workforce. As much as information technologies are being used in agriculture today, such programs must prepare students with not only the knowledge, but skill in using information technologies in relevant agricultural applications. What impact does enrolling in a specific agriculture course have on students' development of information technology skills needed to be successful in information technology careers? It is hoped that daily use of such technologies will help students improve their information technology skills, helping make them savvy to enter the IT workforce and apply their skills in an agricultural setting.

Purpose and Objectives

The purpose of this study was to determine if students in an Agricultural and Environmental Science and Technology (AEST) program developed more information technology skills after being enrolled in an introductory agriscience technology course. Furthermore, this study sought to determine if students who were enrolled in either a biology or business course developed more information technology skills after being enrolled in their respective course. Specifically, the objectives of this study were:

1. To identify students' self-perceived skill levels using information technologies at the beginning of the school year.
2. To identify students' self-perceived skill levels using information technologies at the end of the school year.
3. To determine if students developed more skills using information technology from the beginning of the school year to the end of the school year.
4. To determine if AEST students developed more skills using information technology from the beginning of the school year to the end of the school year
5. To determine if biology/business students developed more skill using information technology from the beginning of the school year to the end of the school year

Methods and Procedures

The population for the study consisted of 1,312 secondary students enrolled in either an Agricultural and Environmental Science and Technology (AEST) program (N = 14) or a Biology/Business program (N = 14) from all geographical areas of Mississippi. Biology/business programs were used as a comparison group because such programs taught similar science and technological content or technological skills as did the AEST programs.

Biology/business programs selected for the study were from schools that did not have an AEST program.

Data were collected through a questionnaire developed by the researchers. The questionnaire consisted of six parts. The part of the questionnaire used to collect data on students' self-perceived skills level using information technologies consisted of 32 skills. Students rated the 32 skills on a Likert-type scale as having (1) No Skill, (2) Few Skills, (3) Some Skills or (4) Many Skills to assess students' self-perceived skill level.

AEST and biology/business teachers agreeing to allow their classes to participate in the project checked the questionnaire for content validity. Teachers reviewed and edited the proposed instrument. Teachers also added and/or deleted items, recommended more appropriate wording, and suggested an appropriate instrument format. Final decisions were made by group consensus. Teachers also recommended procedures for data collection and suggested placing survey instruments on-line to expedite the data collection process. Face validity and reliability of this part of the questionnaire were determined through a pilot test on state officer candidates attending the state FFA convention and re-administered at the state leadership conference. A test-retest reliability coefficient measuring .66 for this section of the instrument was calculated. Even though the reliability coefficient was low, such reliability coefficients are acceptable according to the recommendations by Nunnally and Bernstein (1994) for instruments that are developed and used for the first time.

Teachers were instructed to collect data at the beginning of the school year between September 10 and September 21, 2001. Schools on block scheduling also collected data again in January 2002 for new students enrolling the respective AEST/biology/business courses. Teachers were instructed to collect data at the end of the school year between April 1 and April 19, 2002. Schools on block scheduling also collected data again in December 2001 for students completing the course at the end of the semester. Seventeen of the 28 teachers utilized the online instruments and had their students complete the instruments on-line. The remaining 11 teachers were supplied with scanable instruments for data collection. AEST teachers surveyed all students enrolled in the Concepts of Agriscience Technology course while biology/business teachers surveyed introductory classes made up of 9th and 10th grade students.

Data were summarized using descriptive statistics. Frequencies and percentages were used to describe demographic characteristics and the self-perceived skill level of students using information technologies. McNemar's Chi Square was used to determine if students' self-perceived skill levels using information technologies changed from the beginning of the school year to the end of the school year. McNemar's Chi Square is similar to a correlated-samples t-test that compares two sets of data from a single group in a pre/post test sense (Huck, 2000). This test is used to test the homogeneity of proportions within a group. Alpha levels were set a $p = .05$ a priority.

Findings

A census of 1,312 secondary students from 14 AEST programs and 14 biology/business programs in Mississippi were surveyed. From the population, 1,196 students completed the survey instrument at the beginning of the school year or semester, yielding a 91 percent response rate. At the beginning of the school year, 52 percent of those who responded to the instrument were male while 48 percent of the respondents were female. The majority of those who responded were 9th graders (53 percent) and 32 percent were 10th graders. Another 10 percent were in the 11th grade with only 5 percent in the 12th grade. Caucasians comprised 55 percent of the participants while African Americans comprised 42 percent. Hispanic Americans, Asian Americans, and individuals reporting to be of mixed ethnicity comprised the remaining 3 percent.

At the end of the school year or semester, 808 students completed the survey instrument for a response rate of 62 percent. At the end of the school year, 50 percent of those who responded to the instrument were female while 50 percent of the respondents were male. The majority of those who participated were 9th graders (52 percent) and 32 percent were 10th graders. Another 12 percent were in the 11th grade with only 4 percent in the 12th grade. Caucasians comprised 52 percent of the participants while African Americans comprised 45 percent. Hispanic Americans, Asian Americans, and individuals reporting to be of mixed ethnicity comprised the remaining three percent.

Self Perceived Skill Level Using Applied Information Technologies: Fall 2001

Respondents indicated at the beginning of the school year their self-perceived skill level on 32 information technology skills. Their responses are presented in Table 1. Nineteen statements had a modal response category of "Many Skills." Two statements had a modal response category of "Some Skills" while two statements had a modal response category of "Few Skills." Seven statements had a modal response category of "No Skill." One statement was bimodal, having equal responses on "Few Skills" and "Some Skills."

In this discussion, only statements with modes that included 50% or more of the responses will be discussed. Students perceived they had many skills "Using the telephone" (91%), "Operating a CD player" (89%), "Operating a cassette tape recorder" (80%), "Using a cell phone" (80%), "Programming the channels on a television" (69%), "Operating the controls found in video games" (67%), "Using an electronic calculator" (64%), "Using a video camera" (53%), "Using e-mail" (51%), and "Programming a telephone answering machine" (51%). Students perceived they had no skill in "Using a Global Positioning System (GPS)" (54%).

Self Perceived Skill Level Using Applied Information Technologies: Spring 2002

Respondents indicated at the end of the school year their self-perceived skill level on 32 information technology skills. Their responses are presented in Table 2. Twenty-one statements had a modal response category of "Many Skills." Five statements had a modal

response category of “Some Skills” while five statements had a modal response category of “No Skill.” One statement was bimodal, having equal responses on “Few Skills” and “Some Skills.”

In this discussion, only statements with modes that included 50% or more of the responses will be discussed. Students perceived they had many skills “Using the telephone” (86%), “Operating a CD player” (85%), “Using a cell phone” (80%), “Operating a cassette tape recorder” (78%), “Programming the channels on a television” (67%), “Operating the controls found in video games” (66%), “Using an electronic calculator” (62%), “Using a video camera” (57%), “Using e-mail” (53%), “Operating a DVD player” (52%), and “Programming a cell phone” (52%).

Differences in Students’ Self-Perceived Skill Levels Using Information Technology

McNemar’s Chi-Square was used to determine if students’ self-perceived skill levels using information technologies changed from the beginning of the school year to the end of the school year. Students self-perceived skill levels changed significantly from the beginning of the school year to the end of the school year for the following skills: “Using e-mail” ($X^2 = 11.392$, $p = .011$), “Preparing spreadsheet using a computer” ($X^2 = 11.537$, $p = .003$), “Preparing a multimedia presentation using a computer” ($X^2 = 24.775$, $p = .002$), “Preparing a graphic design using a computer” ($X^2 = 10.456$, $p = .020$), “Writing your own software programs” ($X^2 = 12.526$, $p < .001$), “Using a digital camera” ($X^2 = 11.712$, $p = .006$), “Using a Global Positioning System” ($X^2 = 6.653$, $p < .001$), “Making a purchase using the Internet” ($X^2 = 2.052$, $p = .024$), “Sending a fax” ($X^2 = 16.601$, $p = .006$), “Using a scanner” ($X^2 = 19.758$, $p < .001$), “Programming a cell phone” ($X^2 = 4.372$, $p = .023$), “Operating a CD burner” ($X^2 = 13.071$, $p < .001$), “Programming an electronic calculator” ($X^2 = 5.390$, $p < .001$), and “Troubleshooting/accessing technical help” ($X^2 = 4.372$, $p < .001$). With all of these information technology skills, a higher proportion of students indicated that they had more skill doing at the end of the school year than they did at the beginning of the school year with each specific information technology skill.

Table 1.

Students' Self Perceived Skill Level Using Information Technology: Fall 2001 (N = 1196)

Information Technology Skill	Percentage			
	No Skill	Few Skills	Some Skills	Many Skills
Preparing documents using a computer	8	24	40	28
Using e-mail	13	13	23	51
Preparing a spreadsheet using a computer	14	30	37	19
Using educational/tutorial software	20	36	28	16
Preparing a multimedia presentation using a computer	32	30	24	14
Programming a VCR	13	15	27	45
Preparing a database using a computer	20	30	30	20
Using the telephone	2	2	5	91
Preparing a graphic design using a computer	20	32	31	17
Operating a cassette tape-recorder	4	4	12	80
Operating the controls found in video games	5	9	19	67
Programming the channels on a television	5	8	18	69
Using a video camera	5	12	30	53
Writing your own software programs	48	30	13	9
Using a digital camera	11	20	31	38
Using a Global Positioning System (GPS)	54	25	14	7
Programming a telephone answering machine	8	16	25	51
Using voice mail	21	20	23	36
Using a cell phone	2	6	12	80
Making a purchase using the Internet	19	17	28	36
Operating a DVD player	21	15	26	38
Operating a CD player	2	4	5	89
Using an electronic calculator	6	10	20	64
Sending a fax	35	25	21	19
Using a scanner	19	22	27	32
Programming a cell phone	16	17	25	42
Installing a caller ID system	19	18	23	40
Using instant messenger	20	17	19	44
Operating a CD burner	32	20	20	28

Programming an electronic calculator	36	28	18	18
Troubleshooting/accessing technical help	41	29	18	12
Installing new programs/components on a computer	28	22	20	30

Table 2.

Students' Self Perceived Skill Level Using Information Technology Skills: Spring 2002 (N = 808)

Information Technology Skill	Percentage			
	No Skills	Few Skills	Some Skills	Many Skills
Preparing documents using a computer	8	24	35	33
Using e-mail	8	14	26	53
Preparing a spreadsheet using a computer	12	25	37	26
Using educational/tutorial software	19	25	35	21
Preparing a multimedia presentation using a computer	23	28	32	18
Programming a VCR	9	18	26	47
Preparing a database using a computer	17	30	32	21
Using the telephone	2	4	8	86
Preparing a graphic design using a computer	16	31	31	22
Operating a cassette tape-recorder	3	6	14	78
Operating the controls found in video games	4	10	20	67
Programming the channels on a television	4	9	20	66
Using a video camera	4	10	29	57
Writing your own software programs	39	28	22	12
Using a digital camera	7	19	31	44
Using a Global Positioning System (GPS)	40	26	20	15
Programming a telephone answering machine	8	16	28	48
Using voice mail	16	18	27	40
Using a cell phone	2	6	13	80
Making a purchase using the Internet	14	19	24	43
Operating a DVD player	11	12	24	52
Operating a CD player	2	4	9	85
Using an electronic calculator	5	9	24	62
Sending a fax	29	22	27	21

Using a scanner	11	22	28	39
Programming a cell phone	10	14	24	52
Installing a caller ID system	15	17	24	45
Using instant messenger	13	19	20	49
Operating a CD burner	21	16	23	41
Programming an electronic calculator	29	23	22	25
Troubleshooting/accessing technical help	32	30	22	17
Installing new programs/components on a computer	24	20	26	30

Differences in Self-Perceived Skill Levels of AEST Students

McNemar's Chi Square was used to determine if AEST students' self-perceived skill levels using information technologies changed from the beginning of the school year to the end of the school year as a result of being enrolled in the Concepts of Agriscience Technology Course. Descriptive data for significant skills are reported in Table 3. AEST students self-perceived skill levels changed significantly from the beginning of the school year to the end of the school year for the following skills: "Preparing spreadsheet using a computer" ($X^2 = 22.923, p = .001$), "Using educational software" ($X^2 = 11.673, p = .003$), "Preparing a multimedia presentation using a computer" ($X^2 = 28.127, p = .042$), "Preparing a database" ($X^2 = 4.060, p < .001$), "Preparing a graphic design using a computer" ($X^2 = 8.175, p = .007$), "Writing your own software programs" ($X^2 = 14.525, p < .001$), "Using a digital camera" ($X^2 = 10.769, p = .003$), "Using a Global Positioning System" ($X^2 = 9.064, p < .001$), "Making a purchase using the Internet" ($X^2 = 7.529, p = .003$), "Operating a DVD player" ($X^2 = 8.867, p < .001$), "Sending a fax" ($X^2 = 9.094, p = .007$), "Using a scanner" ($X^2 = 14.273, p < .001$), "Using instant messenger" ($X^2 = 5.797, p = .001$), "Operating a CD burner" ($X^2 = 13.071, p < .001$), "Programming an electronic calculator" ($X^2 = 5.390, p < .001$), "Troubleshooting/accessing technical help" ($X^2 = 4.372, p < .001$), and "Installing new programs" ($X^2 = 22.923, p = .001$). With all of these skills, a higher proportion of AEST students indicated they had more skills doing the specific information technology skill at the end of the school year than they did at the beginning of the school year.

Differences in Self-Perceived Skill Levels of Biology/Business Students

McNemar's Chi Square was used to determine if biology/business students' self-perceived skill levels using information technologies changed from the beginning of the school year to the end of the school year as a result of skills developed in their respective courses. Descriptive data for significant skills are reported in Table 4. Biology/business students self-perceived skill levels changed significantly from the beginning of the school year to the end of the school year for the following skills: "Preparing a multimedia presentation using a computer" ($X^2 = 28.127, p = .042$), "Operating a DVD player" ($X^2 =$

4.060, $p < .001$), “Using a scanner” ($X^2 = 14.273$, $p < .001$), and “Operating a CD burner” ($X^2 = 13.071$, $p < .001$). With all of these skills, a higher proportion of biology/business students indicated they had more skills doing the specific information technology skill at the end of the year than they did at the beginning of the year.

Table 3.
Differences Between AEST Students Self Perceived Skill Levels

Information Technology Skill	n	Percentage				X^2	p
		NS	FS	SS	MS		
Preparing a spreadsheet using a computer	611	17	29	37	18	22.923	.001
	346	14	25	33	28		
Using educational/tutorial software	611	22	38	27	14	11.673	.003
	346	20	22	35	23		
Preparing a multimedia presentation using a computer	611	32	32	21	15	28.127	.042
	346	24	26	31	18		
Preparing a database using a computer	611	25	29	30	16	4.060	<.001
	346	17	30	31	22		
Preparing a graphic design using a computer	611	21	33	30	16	8.715	.007
	346	14	28	35	23		
Writing your own software programs	611	48	31	12	9	14.525	<.001
	346	34	26	24	15		
Using a digital camera	611	12	20	31	37	10.769	.003
	346	6	18	29	47		
Using a Global Positioning System (GPS)	611	55	24	13	8	9.064	<.001
	346	33	24	25	18		
Making an purchase using the Internet	611	21	18	31	31	7.529	.003
	346	14	18	22	46		
Operating a DVD player	611	22	15	28	35	8.867	<.001
	346	14	18	22	46		
Sending a fax	611	37	21	21	22	9.094	.017
	346	30	21	27	22		
Using a scanner	611	20	19	27	35	14.273	<.001
	346	11	21	27	47		

Using instant messenger	611 346	22 13	15 17	22 21	41 49	5.797	.019
Operating a CD burner	611 346	31 19	22 14	20 22	28 44	17.309	.001
Programming an electronic calculator	611 346	37 27	28 20	18 23	17 29	5.990	<.001
Troubleshooting/accessing technical help	611 346	41 27	32 30	18 25	10 19	6.409	<.001
Installing new programs components on a computer	611 346	30 23	20 20	18 24	32 33	15.892	.017

Note: ^aNS = No Skill, FS = Few Skills, SS = Some Skills, MS = Many Skills

N = 611 represents number of respondents at the beginning of the school year, N = 346 represents number of respondents at the end of the school year.

Table 4.

Differences in Self-Perceived Skill Levels of Biology/Business Students

Information Technology Skill	n	Percentage				X ²	p
		NS	FS	SS	MS		
Preparing a multimedia presentation using a computer	585 462	33 22	27 29	26 32	14 17	7.353	.025
Operating a DVD player	585 462	20 9	16 11	24 26	41 53	6.782	<.001
Using a scanner	585 462	18 11	25 24	27 28	31 38	18.571	.01
Operating a CD burner	585 462	33 22	19 18	19 23	29 38	7.493	.002

Note: ^aNS = No Skill, FS = Few Skills, SS = Some Skills, MS = Many Skills

N = 585 represents number of respondents at the beginning of the school year, N = 462 represents number of respondents at the end of the school year.

Conclusions and Recommendations

Overall, students perceived that they had many information technology skills. Students were skilled at using e-mail, using the telephone, operating a cassette recorder, using a video camera, using a cell phone, and operating a CD player. Students had no skill in using a Global Positioning System (GPS). Towards the end of the school year, students had

a more skill in using a GPS system while remaining stable in the skill level on the other information technology skills.

Being enrolled in an introductory agriscience technology course did help AEST students improve their skill level on many information technology skills. These students were more skilled at the end of the school year preparing spreadsheets, using educational software, preparing multimedia presentations, preparing databases, preparing graphic designs, using digital cameras, making Internet purchases, operating DVD players, using scanners, operating CD burners, troubleshooting/accessing technical help, and installing new programs. Biology/business students only increased their skill level in preparing multimedia presentations, operating DVD players, using scanners, and operating CD burners.

While it does appear that being enrolled in an introductory agriscience technology course does improve agriscience students' skill levels in information technology, one must also be aware of the skills that are being developed. Many of the skills students responded to are commonplace today in society. If educational programs are to truly prepare students with the information technology skills needed for the workforce in the future, educators must plan and design programs incorporating the information technology skills identified by the Assessment and Qualifications Alliance (2002). Curricula and learning activities focusing on the application of information technology skills in agriculture must reflect these skills. The researchers recommend a review of the AEST curriculum in order to incorporate more of these applied information technology skills as defined by the Assessment and Qualifications Alliance (2002) into the instructional materials.

Even though it may appear that students enrolled in the AEST program may be developing more skills as a result of the curriculum they are completing, are AEST students developing their skills through that introductory agriscience technology course, or are their other factors influencing their skill development? Many of the skills identified on this research are commonplace and do not reflect with business and industry is looking for in their workers. Future research studies looking at information technology skills should reflect the actual information technology skills needed in today's industries, especially in agriculture. Such skills needed by the agricultural industry, as identified through appropriate research studies, can help educators plan appropriate program addressing the information technology skills needed by its workers. Additional research also needs to be conducted to control for possible extraneous factors that might influence students' information technology skill development.

References

- Assessments and Qualifications Alliance (2002). *Key skills: Communication, application of number, and information technology*. Manchester, England: Aldon House.
- Atkinson, E. S. (1999). Key factors influencing pupil motivation in design and technology. *Journal of Technology Education, 10*(2), 4-25.
- Gupta, U. G. & Houtz, L. E. (2000). High school students' perceptions of information technology skills and careers. *Journal of Industrial Technology, 16*(1), 2-8.
- Huck, S. W. (2000). *Reading statistics and research*. New York: Addison Wesley Longman.
- Kosakowski, J. (1998). *The benefits of information technology*. Retrieved May 22, 2003 from <http://www.ericfacility.net/ericdigests/ed420302.html>
- Meares, C. A. & Seargent, Jr. J. F. (1999). *The digital work force: Building infotech skills at the speed of innovation*, Office of Technology Policy. Retrieved October 1, 2001 from <http://www.ta.doc.gov/reports/techpolicy/digital.pdf>
- Naughton, J. (1986). What is 'technology' anyway? In A. Cross & B. McCormick (Eds.), *Technology in Schools* (pp. 2-10). Milton Keynes: Open University Press.
- Nunnally, J. C. & Bernstein, I. H. (1994). *Psychometric theory*. New York: McGraw-Hill.
- Office of Technology Policy (n.d.). *America's new deficit: The shortage of information technology workers*. Washington, DC: U.S. Department of Commerce.
- Rivero, V. (2000, February). National Educational Technology Reports Released. *Converge, 4*, 23.