The Relationship of Selected Teacher and Program Characteristics to Technology Adoption in Agriscience Education Programs

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Abstract

This study addressed factors related to the adoption of technology in secondary agriscience education programs. Agriscience teachers have adopted technology at a substantial level, although they can still do more with technology. Several factors are related to their adoption of technology. Those teachers with Internet connections at home, interactive CDs, laser disc player or standalone CD players, and teacher e-mail accounts adopt technology at a higher level. Also, teachers who are self-taught, who have attended college courses, or who have received training from colleagues, adopt technology at a higher level. Several teacher related factors are relevant to the adoption of technology: 1) As teachers perceive increased barriers to implementing technology in their instruction, their adoption of technology decreases; 2) As teachers experience increased technology anxiety, they are less likely to adopt technology in the teaching/learning process; and 3) Technology adoption increases as teachers perceptions of their own teaching effectiveness increases.

Teachers cannot adopt technology if they don't have it available for their use. Agriscience teachers should work with their school administrators to obtain the technology they need for instruction. Also, school administrators can play a role in removing or alleviating barriers to the adoption of technology. The fact that completion of college courses on the use of technology in instruction is related to technology adoption appears to document college teacher educators' impact on the technology proficiency of agriscience teachers. However, this impact does not appear to be substantial, and college teacher educators may need to improve the effectiveness of technology courses that are designed to prepare teachers to use technology in instruction. Participation in workshops and conferences does not result in increased technology adoption. Workshops and conferences do not have the depth provided in college courses, however, it appears that an assessment of their effectiveness and value is warranted.

Introduction and Theoretical Base

We live in a time of intense technological change, where change seems to be the only stable factor. In the 1970s, Toffler (1970) labeled this rapid change as "Future Shock." As a result, new products are impacting classrooms, which in turn is ". . . . causing more and more confusion about the best way to use it in schools" (Bailey, 1997, p. 57). For example, LCD projectors, Global Positioning Systems, CAD programs, and computers programs such as SimFarm and the Breeding game allow teachers to simulate situations related to the agricultural industry (Peiter & Sexten, 2001). Students no longer rely completely on the teacher for their answers. "The teacher's communications shifts from giving the answers to asking questions–from giving data to providing guiding hints so the student can find the information" (Taylor & Jeffries, 1994, p. 6).

There is little doubt that technology has had an important role in agriscience education. The Internet alone has opened the door to a wealth of information. For example, a search for 'agriculture education' can result in 560,000 web pages in just 0.53 seconds (Shinn, 2001). With the vast information available today, Shinn stresses that learners must be able to critically assess the information they read, whether on the Internet, or in a textbook. He also said that "Teachers are no longer gatekeepers to information, but must be able to help learners interpret data, check for biased sources, and draw conclusions from mixed findings" (p. 4).

"Today's students need not only to know how to learn, but how to analyze and summarize data, make decisions, work in teams, plan solutions to complex problems and be capable of adapting to the unexpected" (Dwyer, 1999, p. 300). Dwyer points out that the traditional learning paradigm is still being used in which teachers lecture while students listen, take notes and demonstrate mastery on objective exams. This paradigm does not provide learners with the necessary knowledge, skills, and attitudes (KSA) for the modern work world. Dwyer stated that technology based learning environments can help students acquire the type of KSAs needed for success. "If the integration of technology in the classroom in the next ten years is to look any different from the last ten, we must focus time, money, and resources in the areas that can have the greatest impact for our students, our teachers" (Fabry & Higgs, 1997, p. 393).

Availability and Adoption of Technology

Schools have made significant progress in implementing technology in helping teachers to use basic technology tools, but they still struggle with integrating technology into the curriculum (Office of Technology Assessment, 1995). Glenn (1997) stated that public support for technology in schools is ". . . . strong and vocal, and there is an expectation that no school can prepare students for tomorrow's society if new technologies are not available for students" (p. 123). Glenn maintained that teacher training has focused on " . . . . word processing, test construction, automated transparency creation, and grading rather than creating a different learning environment" (p. 126). However, the National Center for Education Statistics (2000) studied the use of various technologies in the teaching/learning process. They reported the examples of how teachers had used technology, including computer applications, practice drills, research using the Internet, solving problems, analyzing data, research using CD-ROMs, multimedia reports/projects, graphical presentations, demonstrations/simulations, and student correspondence with others over the Internet.

"Technology can play a vital role in helping students meet higher standards and perform at increased levels by promoting alternative, innovative approaches to teaching and learning" (George, 2000, p. 57). George emphasized that technology is not a substitute for quality teaching, but it can enhance teaching and learning.

In testimony to a joint committee hearing of the U.S. House of Representatives, Dede (1995) indicated that teachers must use technology in a new model of education he called distributed learning to develop and sustain knowledge webs, virtual communities, shared synthetic environments, and sensory immersion. Unfortunately, the focus of technology implementation efforts has been the ". . . . automating of marginally effective models of presentational teaching, rather than innovating via new models of learning through doing" (p.55). Dede indicated that the knowledge webs would incorporate shared investigations, authentic environments, experts and archival resources. These knowledge webs will be implemented over the next two decades.

Glenn (1997) maintained that teacher education efforts must " . . . . begin to integrate student learning, pedagogy, and technology into a wholistic approach" (p. 128). Glenn also indicated that professional development must provide the time and opportunity to participate in collaborative learning and develop creative innovative environments.

What should technology utilization in the teaching/learning process look like? According to George (2000), technology utilization requires 1) a long-term plan for using technology in all aspects of teaching and learning, 2) a technology resource specialist, 3) the incorporation of technology as an integral part of instruction, and 3) professional development for teachers. "Curriculum integration is central if technology is to become a truly effective educational resource, yet integration is a difficult, time consuming, and resource-intensive endeavor" (Office of Technology Assessment, 1995, p. 1).

Technology Training

A task force of the National Council for the Accreditation of Teacher Education (1997) concluded that colleges are not properly preparing teachers to use technology in their teaching. The report stated, "Bluntly, a majority of teacher education programs are falling far short of what needs to be done" (p. 6). Teachers will be less inclined to use technology in their classrooms if college teacher educators do not model the use of technology in their classrooms (Zehr, 1997). Smerdon, et al., 2000 cited several factors that were related to technology adoption, including sources of training–college, graduate work, professional development, and independent learning; availability of technology at school and at home; availability of time in the school schedule for student computer use; and technical support for technology.

Sandholtz, Ringstaff and Dwyer (1997) described an evolutionary process that teachers go through as they continue to increase their use of technology. They described five phases: 1) Entry – teachers adapt to changes in physical environment created by technology; 2) Adoption -

teachers use technology to support text-based instruction; 3) Adaptation – teachers integrate the use of word processing and databases into the teaching process; 4) Appropriation – teachers change their personal attitudes toward technology, and 5) Invention – teachers have mastered the technology and create novel learning environments. Sheingold and Hadley (1990) found that teachers needed five to six years of working with technology before they felt they had developed expertise, and that once they were at this level, they modified instructional strategies and dramatically changed the classroom environment.

Barriers to the Implementation of Technology

Kerr (1989) stated that " . . . . the teacher's world is substantially limited by powerful social and administrative pressures to teach in a particular way" (p. 5). In his 1997 article, Glenn supported Kerr by noting that the organizational structure of schools inhibits teachers' efforts to learn about new technologies and resists innovation.

Fabry and Higgs (1997) found that the major issues in the implementation of technology in the teaching/learning process were: resistance to change, teachers' attitudes, training, time, access, and cost. This is supported by a study by Smerdon, et al. (2000) in which they found that the barriers to the use of the Internet and computers for instruction included lack of computers, lack of release time for teachers to learn how to use technology, and lack of time in the school schedule for student computer use. This was also supported by George (2000) who indicated that the primary obstacle in incorporating technology in the teaching/learning process is the lack of expertise, time, and funds.

Zisow (2000) stated that "Technology is merely a tool. . . . . The key in adapting new technologies lies in teacher style, not technology" (p. 36). Zisow also claimed that whether technology was utilized in the teaching/learning process was dependent on the teaching style of the teacher.

Budin (1999) stated that, until recently, schools had their priorities backwards. They were more concerned with acquiring equipment and software rather than emphasizing staff development and planning for the use of technology. Budin questioned what will happen to support for technology utilization in the future if funding for technology results in test scores, student writing, and other measures that fail to live up to expectations. Budin indicated that curriculum, teacher training, and research have received minimal attention. He also indicated that the use of technology needs to be reconceptualized, in areas such as students and teachers' roles in using technology, how technology fits into the curriculum, what teachers should know and how teachers will learn about technology, and how we should assess the impact of technology. Bosch (1993) reported that teachers did not see computers as part of the normal classroom process and often used them for ancillary activities. He recommended that administrators look beyond the number of computers in schools and determine how computers are being used.

Teaching Effectiveness

"The mere presence of technology in a school or classroom is not guarantee that it will be used effectively. The teacher is the central figure who essentially decides whether to utilize computer technology in the classroom and therefore needs to be aware of or have a basic understanding of how the technology can be integrated and effectively used in the classroom" (Hardy, 1998, p.119).

A critical element in technology adoption is its relationship to teaching effectiveness. Lu and Molstad (1999) defined instruction as ". . . . the process including all the activities purported to influence learners toward some predetermined goal" (169). Lu and Molstad (1999) cited ways technology can improve instructional effectiveness, including 1) multimedia packages allow teachers to interact with large groups, lead discussions, individualize instruction, and direct student attention to key details in the presentation; 2) telecommunication tools allow teachers to communicate with students and other teachers, encouraging articulation of ideas and collaboration; 3) technology enhances students' problem-solving ability; and 4) technology motivates students to learn.

Byron (1995) listed several shortcomings related to teacher effectiveness when using technology in instruction. These shortcomings included the lack of faculty training on the use in instructional technology, classrooms that were not designed to support the use of technology, teachers' doubts about whether technology would improve their performance, and teachers' concerns about whether technology enhances or detracts from teaching and learning.

Technology Anxiety

Most of the research on technology related anxiety has been conducted in the area of computer anxiety and using computers as program or instructional management tools (grade books, databases, presentations, etc.) for teacher use. Fletcher and Deeds (1994) and Kotrlik and Smith (1989) both found that no difference existed in the computer anxiety of agriculture teachers and the norm for other professionals reported by Oetting (1983), and it was reported in both studies that level of computer skills was a significant explanatory variable of computer anxiety. In addition, Kotrlik and Smith found that no differences existed in computer anxiety among teachers from various vocational fields, namely, agriculture, home economics, business, and industrial arts, and that four variables explained a substantial proportion of the variance in computer anxiety, namely, principal's support of computer use, computer availability at school, perceived mathematical ability, and whether the teacher had received formal computer training.

Budin (1999) stated that the placement of technology into classrooms without teacher preparation and curriculum considerations has produced high levels of anxiety among teachers. This relationship may also exist for all types of technology. Russell (1995) identified six stages that naive users go through when learning to use technology: awareness, learning the process, understanding an application of the process, familiarity and competence, adaptation to other contexts, and creative application to new contexts. "Understanding the stages of learning to use the technology empowers the learner through the knowledge that the feelings of tension and frustration will be overcome" (p. 173). Teachers understanding of these stages will assist them to reduce their anxiety level and pass through the stages more rapidly.

Statement of the Problem

The theoretical base has demonstrated the need for technology in instruction. Numerous studies have been conducted in an attempt to determine how agriscience teachers use technology; however, no studies have been conducted to determine factors that may be related to the adoption of technology in instructional delivery. For this study, technology has been defined as "Employing the Internet, computers, CD-ROMs, interactive media, satellites, teleconferencing, and other technological means to support, enhance, inspire and create learning."

Purpose

This study addressed the adoption of technology in the teaching/learning process by agriscience teachers. The objectives were to:

1. describe the adoption of technology;
2. determine if the availability of technology was related to the adoption of technology in the teaching/learning process;
3. determine if the sources of technology training were related to the adoption of technology in the teaching/learning process;
4. determine if perceptions of technology barriers were related to the adoption of technology in the teaching/learning process;
5. determine if technology anxiety was related to the adoption of technology in the teaching/learning process; and
6. determine if teachers' perceptions of their teaching effectiveness was related to the adoption of technology in the teaching/learning process.

Procedures

Data Source. The population included all secondary agriscience education teachers listed in the directory maintained by the Louisiana Vocational Agriculture Teachers Association. A random sample of 203 teachers was drawn based on Cochran's (1977) sample size formula. After two mailings and a telephone follow-up, 115 teachers returned their surveys for a response rate of 56.7%.

To determine if the sample was representative of the population, *t*-tests were used to compare the grand means of the technology adoption scale, the perceptions of technology barriers scale, and the perceptions of teaching effectiveness scale by response mode (mail or telephone) as recommended by Borg (1987) and Miller and Smith (1983) (See Table 1). These scales are described in the "Data Collection Instrument" discussion below. The grand means of these scales were selected for analysis because they were key variables of interest. No statistically significant differences were found between the means by response mode. It was concluded that the data were representative of the population and the data were combined for further analyses.

Data Collection Instrument. Data were collected using three Scales: Technology Adoption in the Teaching/Learning Process, Perceptions of Barriers to the Adoption of Technology in the Teaching/Learning Process, and Teachers' Perceptions of Their Own Teaching Effectiveness. In addition, information on demographic characteristics of the respondents, technology availability, and technology training was collected. The scales and all questions in the instrument were developed after a review of the literature guided by the theoretical base. The face and content validity of the instrument was evaluated by an expert panel of faculty and doctoral level graduate students. The instrument was pilot tested with agriscience education teachers and needed revisions identified during the pilot test were incorporated into the instrument. These revisions included wording of the instructions and questions. The standards for instrument reliability for Cronbach's alpha by Robinson, Shaver and Wrightsman (1991) were used to judge the quality of the three scales: .80 - 1.00 - exemplary reliability, .70 - .79 - extensive reliability, .60 - .69 - moderate reliability, and <.60 - minimal reliability. All three scales possessed exemplary reliability. Internal consistency coefficients using Cronbach's *alpha* were .97 for the Technology Adoption Scale, .82 for the Technology Barriers Scale, and .87 for the Teachers' Perceptions of Their Own Teaching Effectiveness Scale.

Table 1.
Comparison of Scale Means by Response Wave[a]

Scale	*M*	*SD*	Levene's Test for Equality of Variances		*t*-test for Equality of Means	
			F	*P*	*t*	*P*
Technology Adoption Scale	2.72	.92	.41	.52	.77	.445
Perceived Technology Barriers Scale	2.53	.57	.20	.66	.07	.943
Perceived Teaching Effectiveness Scale	3.57	.59	.17	.69	.07	.944

Note. $N = 115$. Levene's test for the equality of variances did not result in a significant *F* value, therefore, equality of variances was assumed.
[a]Two response waves: responded after one of the first two mailings, or responded after phone follow-up.

Analyses of Data. Descriptive statistics were used to describe the data. Pearson correlation coefficients and the set of descriptors proposed by Davis (1971) were used to analyze correlations between continuous variables. The descriptors are as follows: .70 or higher - very strong association, .50 to .69 - substantial association, .30 to .49 - moderate association, .10 to .29 - low association, and .01 to .09 - negligible association. Point bi-serial correlations and the set of descriptors proposed by Davis (1971) were used to analyze the correlations between nominal and continuous variables.

Results

Over two-thirds of the agriscience teachers (67.8%) had a computer in their office and two-thirds had an office computer connected to the Internet (66.1%). Many had computers and Internet connections at home even though they did not have them at school. Most of the teachers had a home computer (90.4%) and Internet access at home (84.3%). Almost three-fourths (73.0%) had e-mail accounts, while 39.1% had interactive CDs, 16.5% had laser disc players or standalone CD players, and 14.3% reported their students had e-mail accounts.

Most of the teachers (86.1%) used workshops and conferences as their source of technology training more than any other source. Other sources included self-taught (73.0%), colleagues (59.1%), and college courses (43.5%). Most of the teachers (84.3%) were male, their mean age was 43.58 (SD = 10.95), and their average years of teaching was 17.41 (SD = 10.82).

The Adoption of Technology. The teachers responded to the 15 statements in the adoption of technology in the teaching/learning process scale using a five-point Likert type scale that ranged from 1 (not like me at all) to 5 (just like me). The scale included items such as "I emphasize the use of technology as a learning tool in my classroom or laboratory" and "I assign students to use the computer to do content related activities on a regular basis." The scale was designed so that higher responses on the scale indicated a more substantial adoption of technology than was indicated by the lower responses. The adoption of technology scale grand mean was 2.73 (*SD* = .92), which indicated that the teachers perceived the items in the technology adoption scale were "some like me." Since higher grand means on this scale indicated higher technology adoption, this indicates that agriscience teachers had adopted technology at a moderate level.

Technology Barriers. The perceived technology barriers scale contained 11 items. The teachers responded using a four-point Likert type scale, that ranged from 1 (not a barrier) to 4 (major barrier). The scale included items such as "availability of technology for the number of students in my classes," "access to the Internet at my school," and "having enough time to develop lessons that utilize technology." The scale was designed so that higher responses on the scale indicated more substantial perceived barriers. The perceived technology barriers scale grand mean was 2.53 (*SD* = .57), which indicated that the agriscience teachers perceived moderate barriers existed.

Teaching Effectiveness. A researcher developed scale was used to determine the teachers' perceptions of their own teaching effectiveness. The teachers responded to seven items using the following Likert type scale: 1 = Strongly Disagree, 2 = Disagree, 3 = Undecided, 4 = Agree, and 5 = Strongly Agree. All items in this scale were worded in superlative language–strongly agreeing with the statements in this scale indicated the teacher perceived they were excellent in their teaching effectiveness. The items included statements such as "I am among the very best teachers at my school" and "My students would rate me as one of the very best teachers they have ever had." The grand mean of *M* = 3.57 (*SD* = .59) revealed that teachers agreed with the construct measured by this scale, which indicates that they perceive they are effective teachers.

Technology Anxiety. A single item was used to assess the teachers level of technology anxiety, "How much anxiety do you feel when you think about using technology in your instruction?" The teachers responded using the following scale: 1 = No Anxiety, 2 = Some Anxiety, 3 = Moderate Anxiety, and 4 = High Anxiety. Agriscience teachers felt some anxiety (*M* = 1.88, *SD* = .85) when they thought about using technology in their instruction.

Relationship of Technology Availability to Technology Adoption. Point bi-serial correlations were used to determine if statistically significant correlations existed between the availability of selected technology and their technology adoption scale grand mean. A moderate association existed between teachers having two types of technology and the technology adoption scale grand mean, namely, an Internet connection at home and interactive CDs. Also, a moderate relationship existed for teachers who had a teacher e-mail account, a computer at home, or laser disc or standalone CD players. Teachers with the technology listed adopted technology in their teaching at a higher level (See Table 2).

Relationship of Technology Training Sources to Technology Adoption. The respondents were asked about their sources of technology training. Point bi-serial correlations were used to determine if statistically significant correlations existed between their use of these training sources and their technology adoption scale grand mean. There was a moderate positive association between agriscience teachers reporting they received their technology training through self-taught activities and the technology adoption scale grand mean. There was a low positive association between teachers receiving technology training in college courses and from colleagues, and the technology adoption scale grand mean. Teachers who had received training by self-directed activities, in college courses, and from colleagues had adopted technology at a higher level than teachers who had not received training from these sources (See Table 3).

Table 2
Point Bi-Serial Correlations between the Availability of Technology for Use in Teaching and the Technology Adoption Scale Grand Mean

Technology	r_{pb}	*P*	Effect Size
Internet connection at home	0.33	0.000	Moderate association
Interactive CDs	0.33	0.000	Moderate association
Teacher e-mail account	0.28	0.003	Low association
Computer at home	0.24	0.011	Low association
Laser disc player or standalone CD players	0.22	0.019	Low association
Student e-mail accounts	0.12	0.198	Negligible association
Computer in their office	0.11	0.268	Negligible association
Internet connection in their office	0.10	0.277	Negligible association

Note. *N* = 201. Effect sizes were interpreted using the set of effect size descriptors proposed by Davis (1971).
[a]Respondents checked (/) the technology they had available for use in teaching.

Table 3. *Point Bi-Serial Correlations between Sources of Training and the Technology Adoption Scale Grand Mean*

Source of Training[a]	r_{pb}	*P*	Effect Size
Self-taught	0.30	0.001	Moderate association
College courses	0.25	0.008	Low association
Colleagues	0.21	0.026	Low association
Workshops/conferences	0.06	0.558	Negligible association

Note. *N* = 201. Effect sizes were interpreted using the set of effect size descriptors proposed by Davis (1971).
[a]Respondents checked the sources (/) they had used for their technology training.

Relationship of Perceived Technology Barriers to the Adoption of Technology. A Pearson correlation coefficient was used to determine if a statistically significant correlation existed between the perceived barriers scale grand mean and their technology adoption scale grand mean. There was a moderate negative association between teachers perceptions of barriers to the adoption of technology scale grand mean and the adoption of technology scale grand mean. As teachers' perceived increased barriers to adopting technology, technology adoption decreased ($r = -.42$, $p < .001$).

Relationship of Technology Anxiety to Technology Adoption. A Pearson correlation coefficient was used to determine if a statistically significant correlation existed between teachers' technology anxiety levels and their technology adoption scale grand mean. There was a moderate negative association between the teachers' technology anxiety level and their level of technology adoption. As technology anxiety increased, adoption of technology decreased. ($r = -37$, $p < .001$).

Relationship of Perceived Teaching Effectiveness to the Adoption of Technology. A Pearson correlation coefficient was used to determine if a statistically significant correlation existed between the perceived teaching effectiveness scale grand mean and their technology adoption scale grand mean. There was a low positive association between teachers' perceptions of their teaching effectiveness and the adoption of technology scale grand mean. As teachers' perceptions of their own teaching effectiveness increased, technology adoption increased ($r = .20$, $p < .001$).

Conclusions

It was concluded that agriscience teachers have adopted technology at a substantial level, although they can still do more with technology. Several factors are related to their adoption of technology. One obviously important factor is the availability of technology. Those teachers with Internet connections at home, Interactive CDs, laser disc player or standalone CD players, and teacher e-mail accounts adopt technology at a higher level. However, having student e-mail accounts, a computer in their office, and a computer with Internet connection in their office does not result in increased technology adoption.

It was also concluded that another factor that is of interest to teacher educators and other teacher development professionals is the relationship of teachers' sources of training with their technology adoption. Those teachers who are self-taught, who have attended college courses or who have received training from colleagues adopt technology at a higher level. Conversely, no change in adoption occurs for those teachers who received training in workshops and conferences.

Several teacher factors are relevant to the adoption of technology. Their adoption of technology decreases as perceived barriers to the implementation of technology increases. Also, as they experience increased technology anxiety, they are less likely to adopt technology in the teaching/learning process. And technology adoption increases as teachers perceptions of their own teaching effectiveness increases.

Recommendations and Implications

This study has substantial implications for agriscience teacher educators, other teacher development professionals, and school administrators. First, teachers cannot adopt technology if they don't have it available for their use. Agriscience teachers should work with their school administrators to obtain the technology they need for instruction. Also, school administrators can play a role in removing or alleviating barriers to the adoption of technology.

The fact that completion of college courses on the use of technology in instruction is related to technology adoption appears to document teacher educators' impact on the teachers' proficiency with technology. However, this impact does not appear to be substantial, and teacher educators should work to improve the effectiveness of technology courses that are designed to prepare teachers to use technology in instruction. Of greatest concern in the area of teacher training is the fact that participation in workshops and conferences does not result in increased technology adoption. It is recognized that workshops and conferences do not have the depth provided in college courses; however, it appears that an assessment of the effectiveness and value of workshops and conferences is warranted.

From a secondary agriscience education perspective, a need exists for teachers to work toward the adoption of technology in their programs in a way that will enhance agriscience programs. The use of technology in instruction has become very pervasive in all areas of education, including agriscience education, and agriscience educators should be leaders in efforts to maximize the potential of technology in instruction. With the pervasive impact of technology on students' and teachers' careers and lives, teachers must emphasize knowledge acquisition and management, analysis, and application to the teaching/learning process. This requires agriscience teachers to anticipate changes in the use of technology and to pursue opportunities to upgrade their ability to use technology in instruction

The fact that teachers' self-perceived effectiveness is related to technology adoption has several implications. Does this relationship exist simply because better teachers do everything they can to improve their instruction? Do administrators provide more support in the form of technology and training to those teachers who they perceived are "better" teachers? Or, does technology have a direct result of improved instruction. These questions demand definitive answers and additional research should be conducted in agriscience education to determine the impact of technology on instructional quality.

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