

TECHNOLOGY INTEGRATION BY AGRISCIENCE TEACHERS IN THE TEACHING/LEARNING PROCESS

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Abstract

The purpose of this study was to determine how technology was being integrated in the teaching/learning process in secondary agriscience education programs for four distinct and independent phases: Exploration, Experimentation, Adoption, and Advanced Integration. The study was based on the Kotrlik-Redmann Technology Integration Model[®]. The phases in which agriscience teachers are most active are exploration of the potential of using technology in the teaching/learning process, and adopting technology for regular use in instruction; however, they are functioning at a moderate level in both phases. They are not very active in the experimentation phase or in the advanced integration phase. Moderate barriers exist that prevent teachers from integrating technology into the teaching/learning process. Generally, agriscience teachers perceive that they are good teachers, although some have doubts. Agriscience teachers are experiencing a moderate level of technology anxiety. Teachers continue to use traditional sources for their technology training. Teachers' perceptions of barriers to the integration of technology, their technology anxiety, and their perceptions of their own teaching effectiveness are strong predictors of the extent to which agriscience teachers integrate technology in the teaching/learning process.

Introduction and Theoretical Framework

“In times of change, learners inherit the earth, while the learned find themselves beautifully equipped to deal with a world that no longer exists” (Eric Hoffer quoted in Jordan & Follman, 1993, p. 1).

“Technology is changing more rapidly than ever before, causing more and more confusion about the best way to use it in schools” (Bailey, 1997, p. 57). Shinn (2001) agreed by noting that some Internet search engines can search 1.3 billion unique web addresses, search the equivalent of a 70 mile high stack of paper, or locate 14 million web pages about learning in less than one second. In their assessment of barriers to the use of technology in instruction, Fabry and Higgs concluded that “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” (1997, p. 393).

According to the Office of Technology Assessment's 1995 report on teachers and technology, schools have made significant progress in implementing technology and helping teachers to use basic technology tools, but they still struggle with integrating technology into the curriculum. “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” (p. 1).

A task force of the National Council for the Accreditation of Teacher Education (NCATE) 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” (NCATE, 1997,

p. 6). Teachers will be less inclined to integrate technology in their classrooms if teacher education faculties do not model the integration of technology in their classrooms (Zehr, 1997).

Perkins (1992) points out in his book *Smart Schools: Better Thinking and Learning for Every Child*, that "... students are learning and teachers are teaching in much the same way they did twenty or fifty years ago. In the age of CDs and VCRs, communication satellites and laptop computers, education remains by and large a traditional craft" (p. 3). Willis (1997) recommended using technology to place a contemporary, nontrivial, engaging dilemma at the core of the curriculum so that learners can come to some concrete outcome. She also indicated that "... this is quite different from the traditional approach which stresses teacher as lecturer, textbook chapters read, questions at the end of the chapters answered, and, finally, a test over the names, events, dates, categories, etc., covered in the text" (p. 148). Willis also described an instructional strategy using the problem-solving approach called "Mushroom Management" that could be used in technology integration:

1. "Puts 'em in the Dark—introduces a problem, motivating learners to engage in investigating it.
2. Feeds 'em Manure—sets up informational strategies and activities so that students have what they need to do their investigating.
3. Stands Back and Lets 'em Grow—allows learners the time and flexibility to do their investigative work, with the teacher as co-learners and sometimes expert.
4. Chops Off Their Heads and Ships 'em—plans a culminating activity which closes the investigation and moves the students on to another project" (p. 148).

Newman (2000) claims that the debate about the advantages and disadvantages of using technology in instruction is a false issue. She believes that the way technology is used should be based on what educators believe about the teaching/learning process

and that the truly important questions that need to be answered deal with curriculum and instructional design. She maintains that technological applications offer potential as a teaching and learning tool—but "... the way we are using them looks to me like we are following a yellow brick road" (p. 774). Information technology cannot produce learning if the instructional environment fails to provide opportunities for genuine problem solving, decision-making, and communication. "What matters ultimately is the experience that learners have and what they make of that experience" (p. 775).

The Association for Educational Communications and Technology (AECT) defined instructional technology as "... the theory and practice of design, development, utilization, management and evaluation of processes and resources for learning" (Seels & Richey, 1994). For this study, technology was defined as "Employing the Internet, computers, CD-ROMs, interactive media, satellites, teleconferencing, and other technological means to support, enhance, inspire and create learning."

*Extent to Which Technology
Has Been Integrated Into the
Teaching/Learning Process*

"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). 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 (NCES) (2000) studied the integration of various technologies in the teaching/learning process. NCES reported the following examples of how teachers had integrated technology: 44% used technology for classroom instruction, 42% used computer applications, 12% used practice drills, 41%

required research using the Internet, 27% had students conduct research using CD-ROMs, 27% assigned multimedia reports/projects, 23% assigned graphical presentations of materials, 21% assigned demonstrations/simulations, 20% required students to use technology to solve problems and analyze data, and 7% assigned students to correspond with others over the Internet (NCES, 2000).

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 their expertise, and that once they were at this level, they modified instructional strategies and dramatically changed the classroom environment.

An NCES study (Smerdon, Cronen, Lanahan, Anderson, Iannotti, & Angeles, 2000) reported that several factors were related to the extent to which technology was integrated into schools: socioeconomic characteristics of students; teachers' years of experience; sources of training—college, graduate work, professional development, and independent learning; availability of technology at school and at home; incentives for integrating technology such as support for participating in training or provision of release time for teachers to learn how to use this technology; availability of time in the school schedule for student computer use; and technical support for technology integration. However, Kotrlik, Harrison, Redmann, and Handley (2000) found that degree held, gender, ethnicity, age, years teaching experience, usefulness of instructional technology, participation in the state vocational convention, and

participation in regional and national Association for Career and Technical Education conventions did not explain the variance in the value vocational teachers placed on information technology.

*Barriers to the Implementation
of Technology in the
Teaching/Learning Process*

Several authors have written about 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 article, Glenn supported Kerr by noting that the organizational structure of schools inhibits teachers' efforts to learn about new technologies and resists innovation (Glenn, 1997).

In their review of several meta-analyses, Fabry and Higgs (1997) found that the major issues in the implementation and integration 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) for NCES 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.

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 integration of technology. Budin questioned what will happen to support for technology integration in the future if funding for technology integration 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 whether real integration across the curriculum had occurred.

A Rand Corporation Study (Berman & McLaughlin, 1978) found that innovations tend to fail when they are implemented without considering the complex social nature of schools. It is not enough to simply make teachers better or more efficient—they must like new technology better than what they already have.

Relationship of Teaching Effectiveness to Technology Integration

A critical element in technology integration 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” (p. 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.

Wardlow and Johnson (1999) addressed college faculty members’ level of skill in educational technologies in their broader study of faculty teaching skills and interest in teaching improvement. Over half rated themselves much lower in the area of educational technology than on their self-ratings of teaching activities. Faculty had a moderate level of interest in learning more about the 12 items in the education technologies scale. This study did not address the integration of technology in the teaching/learning process. Teachers who use technology in their classrooms seem to change their instructional methods and attitudes (Jordan & Follman, 1993).

Technology Anxiety

No research could be found that addressed teachers’ anxiety relative to implementing technology in the teaching/learning process. 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) found that no difference existed between 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 (1989) 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. 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. Technology and psychological support are important because early successful encounters with technology will create enthusiasm and build teachers' confidence. These observations were supported by Hardy (1998) in her study of teacher attitudes toward and knowledge of computer technology.

Need for the Study

There are many studies that document improvement in learning (Khalili & Shashoani, 1994; Moore & Kearsley, 1996), and there are also many studies that have not found any significant differences in learning between technologically based and traditional instructional approaches (Moore & Kearsley, 1996). This debate continues, but one fact has been established. A number of organizational and political realities indicate that technology-based instruction is a viable alternative (Bower, 1998). Bower summarized the need for the integration of technology in the teaching/learning process in the following way: "Is computer based instruction popular with students and educators? Yes. Does it improve student performance? Maybe. Is it worth the cost? Probably. Must we continue to explore this innovative pathway to education? Definitely." (p. 65).

Even though numerous studies have been conducted about how agriscience teachers use technology, no research has been conducted to determine how these teachers are integrating technology in the teaching/learning process. This information is critical to ensure that technology integration achieves its maximum level of

effectiveness and impact. This study was designed to determine how technology is being implemented in agriscience education programs.

The Kotrlik-Redmann Technology Integration Model[©]

The four distinct and independent phases of the Kotrlik-Redmann Technology Integration Model (Kotrlik & Redmann, 2002) were developed based on the theory and research cited above:

1) *Exploration - Thinking About Using Technology.* Teachers seek to learn about technology and how to use it.

2) *Experimentation - Beginning to Use Technology.* Physical changes start to occur in classrooms and laboratories. Instructors focus more on using technology in instruction by presenting information using presentation software and doing a few instructional exercises using spreadsheets, databases, word processors, games, simulations, the Internet, and/or other computer tools.

3) *Adoption - Using Technology Regularly.* Physical changes are very evident in the classroom and/or laboratory with the computers becoming a focal point in the classroom and/or laboratory organization. Instructors employ presentation software and technology-based instructional exercises using games, simulations, spreadsheets, databases, word processors, the Internet or other technology tools as a regular and normal feature of instructional activities. Student shared responsibility for learning emerges as a major instructional theme.

4) *Advanced Integration - Using Technology Innovatively.* Instructors pursue innovative ways to use technology to improve learning. Students take on new challenges beyond traditional assignments and activities. Learners use technology to collaborate with others from various disciplines to gather and analyze information for student learning projects. The integration of technology into the teaching/learning process has led to a higher level of learning.

Purpose and Objectives

The purpose of this study was to determine what factors explain the degree of integration of technology into the teaching/learning process in secondary agriscience education programs. The objectives were to determine:

1. the extent to which technology has been integrated into the teaching/learning process;
2. the magnitude of barriers that may prevent agriscience teachers from integrating technology into the teaching/learning process;
3. agriscience teachers' perceptions of their teaching effectiveness;
4. the technology anxiety of agriscience teachers;
5. the sources of technology training and types of technology used by agriscience teachers; and
6. if selected variables can explain a significant proportion of the variance in technology integration scores.

Research Methods and Procedures

Population and Sample

The population for this study included all agriscience teachers in secondary schools in Louisiana. All agriscience teachers listed in the *2001-2002 Louisiana Agriscience Education Teachers Directory* served as the frame for the study. Using Cochran's (1977) sample size formula, a random sample of 203 teachers was selected.

Instrumentation

The scales and items used on the instrument were selected following a review of the literature and were grounded in the theoretical base of the study. The face and content validity of the instrument were evaluated by an expert panel of agriscience teachers, university faculty and doctoral level graduate students, and then pilot tested with 35 teachers. Changes recommended by the validation panel, where appropriate, and those identified as needed during the pilot test, were incorporated into the instrument. These changes occurred in the wording of

items, the design of scales, and in the instructions for completing the instrument. The standards for instrument reliability for Cronbach's alpha by Robinson, Shaver and Wrightsman (1991) were used to judge the quality of the two scales in the instrument: .80 - 1.00 - exemplary reliability, .70 - .79 - extensive reliability, .60 - .69 - moderate reliability, and <.60 - minimal reliability. Using these standards, all scales possessed exemplary reliability. Internal consistency coefficients for the scales in the instrument were calculated using Cronbach's *alpha*: Exploration - $\alpha = .84$, Experimentation - $\alpha = .90$, Adoption - $\alpha = .96$, Advanced Integration - $\alpha = .90$, Barriers to Integration - $\alpha = .82$, and Teachers' Perceptions of Their Own Teaching Effectiveness - $\alpha = .87$.

Data Collection

The responses were collected using two mailings and a systematic follow-up of a random sample of non-respondents. Each mailing consisted of a questionnaire, cover letter, and stamped, addressed return envelope. A response rate of 57% (115 out of 203) was attained after the completion of the two mailings and the telephone follow-up.

Data Analyses

The data were analyzed using descriptive statistics for objectives one thru five. Stepwise multiple regression analysis was used for objective six. The alpha level was set a priori at .05. To determine if the sample was representative of the population and to control for non-response error, the scale means for the four primary scales were compared by response mode (mail versus phone follow-up) as recommended by Borg (1987) and Miller and Smith (1983). There were no statistically significant differences between the means by response mode for the four primary scales in the instrument. It was concluded that no differences existed by response mode, and the data were representative of the population. The mail and phone follow-up responses were combined for further analyses.

Findings

Objective 1

The four subscales of the Technology Integration Scale (TIS) (©2002) were used to determine the extent to which technology had been integrated into the teaching/learning process in agriscience

education programs. The teachers responded to 34 items using the following Likert type scale: 1 = Not Like Me At All, 2 = Very Little Like Me, 3 = Some Like Me, 4 = Very Much Like Me, and 5 = Just Like Me. Examples of the items from the four subscales are presented in Table 1.

Table 1

Examples of Items on the Four Subscales of the Technology Integration Scale®

| Statement | <i>M</i> | <i>SD</i> |
|--|-------------------------|------------|
| Subscale: Exploration (5 statements in subscale) | Grand Mean: 3.17 | .95 |
| 2. I want to take a course to learn how to use technology in the teaching/learning process. | | |
| 3. I talk with my principal or fellow teachers about using technology in my instruction. | | |
| Subscale: Experimentation (9 statements in subscale) | Grand Mean: 2.39 | .83 |
| 9. I am just beginning to use instructional exercises that require students to use the Internet or other computer programs. | | |
| 11. I am just beginning to experiment with ways to use technology in the classroom. | | |
| Subscale: Adoption (15 statements in subscale) | Grand Mean: 2.79 | .94 |
| 17. I emphasize the use of technology as a learning tool in my classroom or laboratory. | | |
| 18. I assign students to use the computer to do content related activities on a regular basis. | | |
| Subscale: Advanced Integration (4 statements in subscale) | Grand Mean: 2.14 | .94 |
| 26. I encourage students to design their own technology-based learning activities. | | |
| 33. I incorporate technology in my teaching to such an extent that my students use technology to collaborate with individuals at other locations (other classes, other schools, other states or countries, etc.) | | |

Note. $N = 115$. Scale: 1 = Not Like Me at All, 2 = Very Little Like Me, 3 = Some Like Me, 4 = Very Much Like Me, and 5 = Just Like Me. The Technology Integration Scale (TIS)® is based on the Kotrlik-Redmann Technology Integration Model (©2002).

Analysis of the grand means for two constructs, Exploration - Thinking About Using Technology ($M = 3.17$, $SD = .95$), and Adoption - Using Technology Regularly ($M = 2.79$, $SD = .94$), revealed that the teachers perceived the descriptions in these two scales were "Some Like Me." Analysis of the grand means for the other two constructs, Experimentation - Beginning to Use Technology ($M = 2.39$, $SD = .83$), and

Advanced Integration - Innovative Use of Technology ($M = 2.14$, $SD = .94$), revealed that the teachers perceived the descriptions in these two scales were "Very Little Like Me."

Objective 2

A researcher-developed scale was used to determine the magnitude of barriers that may prevent agriscience teachers from

integrating technology into the teaching/learning process. The teachers responded to 11 items using the following Likert type scale: 1 = Not a Barrier, 2 = Minor Barrier, 3 = Moderate Barrier, and 4 = Major Barrier. The items included statements such as "Having enough time to develop lessons that use technology" and "My ability to integrate technology in the teaching/learning process." The grand mean revealed that agriscience teachers perceive that moderate barriers exist that prevent them from integrating technology into the teaching/learning process ($M = 2.53$, $SD = .57$) (See Table 2).

Objective 3

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 on 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.

Table 2

Statements Included on the Scale Measuring Barriers That May Prevent Agriscience Teachers from Integrating Technology in the Teaching/Learning Process

| Statement |
|--|
| 1. Having enough time to develop lessons that use technology. |
| 2. Scheduling enough time for students to use the Internet, computers, or other technology in the teaching/learning process. |
| 3. Availability of technology for the number of students in my classes. |
| 4. Availability of technical support to effectively use instructional technology in the teaching/learning process. |
| 5. Administrative support for integration of technology in the teaching/learning process. |
| 6. My ability to integrate technology in the teaching/learning process. |
| 7. My students' ability to use technology in the teaching/learning process. |
| 8. Type of courses I teach. |
| 9. Reliability of the Internet at my school. |
| 10. Access to the Internet at my school. |
| 11. Availability of effective instructional software for the courses I teach. |

Note. $N = 115$. Scale Grand Mean = 2.53 ($SD = .57$). Scale: 1 = Not a Barrier, 2 = Minor Barrier, 3 = Moderate Barrier, and 4 = Major Barrier.

Over one-third (43.9%) of the teachers either disagreed or were undecided when asked whether they agreed with statements that indicated teaching excellence, while only 4.4% of the respondents' grand means

indicated strong agreement or that they perceived they had achieved teaching excellence. Table 3 presents the statements, with scale mean and standard deviation.

Table 3
Teachers' Perceptions of Their Teaching Effectiveness

| Statement |
|---|
| 1. I am among the very best teachers at my school. |
| 2. I am highly effective in teaching the content in my courses. |
| 3. My students would rate me as one of the very best teachers they have ever had. |
| 4. The other teachers in my school would say that I am one of the best teachers at this school. |
| 5. All of my students would evaluate my courses as excellent. |
| 6. I am a role model for other teachers in my school. |
| 7. My principal would say that I am one of the best teachers at this school. |

Note. $N = 114$. Scale Grand Mean = 3.63 ($SD = .59$). Scale: 1 = Strongly Disagree, 2 = Disagree, 3 = Undecided, and 4 = Agree, and 5 = Strongly Agree.

Objective 4

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. The analysis of the data revealed that agriscience teachers feel some anxiety ($M = 1.88$, $SD = .85$) when they think about using technology in their instruction.

Objective 5

The teachers were asked to indicate the sources of their technology training. They were given five sources and instructed to check all that applied to them. Over two-thirds of the teachers had participated in workshops or conferences ($n = 99$ or 86%) or were self-taught ($n = 84$ or 73%), while smaller numbers learned from colleagues ($n = 68$ or 59%), had taken college courses ($n = 50$ or 44%), or used other sources for their technology training ($n = 10$ or 9%).

The teachers were also asked about the technology that was available for their use in teaching. Over two-thirds of the teachers had e-mail accounts ($n = 84$ or 73%), while smaller numbers had interactive CDs ($n = 45$ or 39%), student e-mail accounts ($n = 19$ or 17%), laser disc players or stand-alone CD players ($n = 14$ or 12%), or had other types of technology available ($n = 16$ or 14%).

Objective 6

An analysis was conducted to determine if selected variables explained a significant proportion of the variance in advanced technology integration scores. The grand mean of the advanced integration scale was used as the dependent variable in this analysis.

Nine variables were used as potential explanatory variables: the grand mean of the barriers to the integration of technology scale, the grand mean of the teachers' perceptions of their teaching effectiveness scale, the teachers' technology anxiety, gender (dummy coded as 0 = male, 1 = female), age, whether teachers had a computer in their office, whether the computer in the teachers' office at school had Internet access, whether teachers had a computer at home, and whether the teachers' home computer was connected to the Internet. The last four variables were dummy coded for use in the regression analysis (0 = yes and 1 = no). Three variables explained 23% of the variance in the grand mean of the advanced technology integration scores, which is a medium effect size according to Cohen (1988). The variables were the grand mean of the Barriers to the Integration of Technology scale ($R^2 = .15$), the grand mean of the Teachers' Perceptions of Their Own Teaching Effectiveness scale (additional $R^2 = .04$), and the teachers' technology anxiety (additional $R^2 = .03$).

The variables that did not explain a significant proportion of the variance were gender, age, whether the teacher had a computer in the office, whether the teacher had Internet access at their school office, whether the teacher had a computer at home,

and whether the teacher had Internet access at home. The ANOVA table for the regression analysis is presented in Table 4 and the model summary is presented in Table 5.

Table 4

ANOVA Table for the Stepwise Multiple Regression Analysis of Advanced Technology Integration Scale Scores

| Source | SS | df | MS | F | p |
|------------|-------|-----|------|-------|------|
| Regression | 22.06 | 3 | 7.35 | 10.64 | .000 |
| Residual | 75.34 | 109 | 0.69 | | |
| Total | 97.40 | 112 | | | |

Table 5

Model Summary: Multiple Regression Analysis of Teacher Responses to the Technology Integration Scale

| Model | R | R ² | Adjusted R ² | Std. Error of the Estimate | Change Statistics | | | | |
|----------------|-----|----------------|-------------------------|----------------------------|-----------------------|----------|-----|-----|---------------|
| | | | | | R ² Change | F Change | df1 | df2 | Sig. F Change |
| 1 ^a | .39 | .15 | .14 | .89 | .15 | 19.80 | 1 | 111 | .000 |
| 2 ^b | .44 | .19 | .18 | .85 | .04 | 5.70 | 1 | 110 | .019 |
| 3 ^c | .48 | .23 | .21 | .83 | .03 | 4.70 | 1 | 109 | .032 |

^aPredictors: Barriers ^bModel 1 plus Teachers Perception of Their Own Teaching Effectiveness,

^cPredictors: Model 2 plus Anxiety Level.

Conclusions

This study addressed how technology was being integrated in the teaching/learning process for four distinct and independent phases - Exploration, Experimentation, Adoption, and Advanced Integration. The phases in which agriscience teachers are most active are *exploration* of the potential of using technology in the teaching/learning process, and *adopting* technology for regular use in instruction; however, they are functioning at a moderate level in both phases. They are not very active in the *experimentation* phase or in the *advanced integration* phase. This lack of strong integration of technology by agriscience teachers may be reflective of many educational leaders such as Budin (1999)

who voiced concerns about how technology fits into the curriculum, what teachers should know, and how the impact of technology should be assessed.

Moderate barriers exist that prevent agriscience teachers from integrating technology into the teaching/learning process. This conclusion directly supports the review of several meta-analyses conducted by Fabry and Higgs (1997), and the national study conducted by the NCES (Smerdon et al., 2000). In general, they perceive they are good teachers, although some have doubts. Agriscience teachers are experiencing a moderate level of technology anxiety. Although no previous research exists that documents the technology anxiety of teachers, this conclusion does support previous studies that addressed a type of

anxiety that may be related to technology anxiety, namely, computer anxiety (Fletcher & Deeds, 1994; Kotrlik & Smith, 1989).

Teachers continue to use traditional sources for technology training such as workshops/conferences, college courses, colleagues, and self-directed learning. However, teachers are using workshops/conferences at a higher level than self-directed learning, which differs from previous research on agriscience teachers' computer training as reported by Kotrlik et al. (2000). Teachers' perceptions of barriers to the integration of technology, their technology anxiety, and their perceptions of their own teaching effectiveness are substantial predictors of the extent to which agriscience teachers integrate technology in the teaching/learning process. This indicates that little change has occurred since the Office of Technology Assessment's 1995 report on teachers and technology, in which it was concluded that 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.

Recommendations

The conclusions above reveal that much more needs to be done to encourage and support agriscience teachers in the integration of technology in the teaching/learning process. Certainly, university faculties, leaders in state departments of education, and school administrators have a vital role and a definite responsibility in this effort. In addition, teachers must be encouraged to embrace self-directed learning to support this effort.

Agricultural education leaders must change the way they look at technology integration. Just as our delivery of university courses continues to change to distance learning and other technology-based formats, leaders must develop new models that will result in faster and better integration of technology in the teaching/learning process at the secondary level. It is simply not enough to make teachers "better" users of technology, but

they must be convinced that technology will improve the quality of their instruction and ultimately, student learning.

This appears to be an excellent opportunity to design and implement change processes that will have an impact on technology integration. This process should involve stakeholders at all levels and must be aggressively pursued. Additional research on factors related to technology integration in the teaching/learning process is warranted. This certainly includes research to determine whether teachers are being adequately prepared by teacher education institutions to integrate technology in the teaching/learning process.

Implications

As indicated in the theoretical foundation for this study, Newman (2000) stated that the debate about the advantages and disadvantages of using technology in instruction is a false issue. She stated that information technology cannot produce learning if the instructional environment fails to provide opportunities for genuine problem solving, decision-making, and communication. In effect, Newman was saying that technology is a means to an end.

If agriscience education programs are going to provide the best education possible, they must integrate technology in the process. Agriscience teachers create and maintain an instructional environment in their programs. If their approach to integration of technology in one that reflects doubt and consternation, the potential positive impact of technology integration may be neutralized. Technology integration must be emphasized by all stakeholders in the agriscience education program.

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