Beyond Technology Determinism: Applying a Technology Triangle Model to Assess the Integration of Technology by Florida’s Secondary Agriscience Teachers

By

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ABSTRACT

The potential of instructional technology to improve student achievement and to revolutionize American public schools has become a major focus of attention by educators and policy makers. Secondary agricultural education programs are not immune from the drive toward technology integration. The purpose of the study, therefore, was to assess how Florida secondary Agriscience have integrated technology into their programs and the constraints they confront. Of 55 secondary agricultural teachers sampled, 45 respondents completed the survey questionnaire. The study adopted a modified Technology Triangle Model. Data analysis included descriptive statistics such as percentages, means, and standard deviation.

Among the study’s significant findings were: the relatively high level of technology integration reported by the respondents including: PowerPoint (50%), word processing (78%), use of audio-visuals (95%), electronic grading (78%), requiring students to conduct internet research (48%), and use of computer lab (43%).

Major constraints to technology integration, included rapid technological obsolescence and the resultant high cost of upgrades, teachers’ lack of routine computer trouble-shooting skills, poor facilities for professional development, inadequate access by students to home computer, lack of technology skills, and poor technical support.

In conclusion, teachers will only use instructional technology if they have the needed hardware and software, have the required technology integration skills, receive continuous professional development upgrades, and receive timely technical support to fix hardware and software problems that are synonymous with technology use. These are the challenges that the agricultural education profession must address in order to encourage teachers to integrate technology.
Introduction

Technology is ubiquitous. It is all around us, affecting almost every facet of our daily living. Projections and predictions about future technological possibilities and their potential impact of our lives are almost too astounding as to be regarded as stuff of science fiction. In the highly competitive, knowledge economy of the 21st century, a nation’s stock of technology infrastructure and the human capital to manage it is now generally regarded as the new competitive edge in global trade, in the same way that a nation’s endowments in natural resources and labor dominated the industrial-age economy of the 19th and 20th centuries. National policy makers and educational leaders, therefore, see great potential in instructional technology, not only as a tool to enhance student achievement and prepare the future stock of technologically competent workforce, but also to revolutionize the very nature of American public education. Hence, the integration of technology into the American educational system has become a major focus of attention of policy-makers and educators. Writing on the same subject, Culp, Honey and Mandinach, (2003) noted that technology is increasingly seen not only as a tool for addressing the challenges in teaching and learning, or as a change agent in the educational enterprise, but as a central force in economic competitiveness. According to Kook (1997, P. 56), “the growth of communication networks will change the image of the classroom for the twenty-first century with the global classroom being connected by networks that reach around the world and across subject areas.”

Given the high hopes being placed on technology to revolutionize the American public school system, over the past decade billions of dollars have been committed into upgrading public schools’ technology infrastructure. According to estimates by Dickard (2003), about $40 billion from both the public and private sectors was committed between 1993 and 2003 to upgrade the technology infrastructure in American public schools. Consequently, over the past two decades American public school has experienced an astounding level of growth in technology infrastructure. Anderson & Ronnkvist (1999), for instance estimated that the number of computers in American schools rose from 250,000 in 1983 to 8.6 million in 1998. Cattagni & Farris (2001) also observed that virtually all schools now have some form of internet connection. Expectations are that once the problem of inadequate technology infrastructure in the public school system is resolved, the sheer force of technological superiority and its demonstrated relative advantage as a tool in the teaching-learning process would revolutionize the public school system and lead teachers to integrate technology into their curricula (Tyack & Cuban, 1995).

While there is no doubt that the huge investment in the last two decades has contributed to improving the technology infrastructure and internet connectivity in the American public schools, increasingly evidences are beginning to emerge that this “if you install it, they would use it”, technology deterministic approach to technology integration in the educational arena is not only over-simplistic, but wildly optimistic (Alonge, 2004; Curry, 2003). Smerdon, Cronen, Lanahan, Anderson, Iannotti & Angeles (2000), while observing that there has been an increase in teacher use of technology, concluded that the level of utilization is not high enough as to affect education to the significant level initially envisaged by technology proponents. Numerous studies have begun to document that getting teachers to integrate technology into their curricula is a complex, multidimensional process involving the dynamic interactions among human resource development, structural, institutional, and societal factors, far beyond the rather simplistic, technological-deterministic models that have
dominated efforts to integrate technology into the teaching-learning enterprise. Unfortunately, and in spite of the evidence to the contrary, most studies of the process of technology integration into the school systems tend to be constructed within the narrow technology-deterministic framework, while often neglecting the more appropriate holistic, and systemic approaches.

**Purpose & Objectives**

Agricultural education programs as integral parts of the American public school curriculum are also grappling with the challenges posed by the technology integration movement. In fact, in many school systems, agricultural education programs as integral part of the workforce development or vocational education departments, are often in the forefront in integrating technology into the school curriculum (Alonge, 2004). It is becoming increasingly clear that for secondary agricultural education programs to survive in this era of educational accountability based largely on student achievement in standardized tests of reading, writing, and mathematics skills, they must demonstrate that beyond preparing students for careers in the food and fiber industry, that they provide value-added services to the educational system. Providing leadership in the integration of technology into the educational process is one way that agricultural education can demonstrate their value-added contribution.

The purpose of the study, therefore was to apply a modified Technology Triangle Model (Kemm, 2001) to assess the perceptions of Florida Agriscience teachers about the educational value of instructional technology, their level of technology integration, and the constraints that confront them in the technology integration process. Specifically, the study analyzed the technological, human perception, professional development, institutional, and wider societal factors that are important in determining Florida Agriscience teachers’ ability to integrate instructional technology, mainly computers and the associated software and programs, into their programs. The study attempted to provide answers to the following specific research questions:

1. What are the perceptions of secondary agricultural teachers in Florida regarding the educational benefits of integrating technology into the teaching-learning process?

2. To what extent have Florida agricultural teachers integrated technology into their teaching-learning activities, through such practices as, using computer applications for teaching, performing routine management and record-keeping activities, requiring students to conduct internet research, using the internet as a sources of curriculum content, and for communicating with their students and experts in the profession, developing multimedia presentations, and requiring students to demonstrate high level technology skills?

3. What are the infrastructure, structural, professional development, institutional, and societal constraints hampering Florida Agricultural teachers from integrating technology into their curricula?

4. What are the implications of the study for improving the level of technology integration into agricultural education curriculum in general?
Theoretical Base

The innovation diffusion theory has undergirded many past attempts to study how innovations diffuse, are adopted, and integrated into a social system. Often associated with the seminal work of Rogers (1995), proponents of the innovation diffusion theory have identified four major factors that influence the rate of technology adoption. The factors include, the nature of the innovation itself, the innovation communication process, time, and the nature of the social system that is doing the adopting. The fingerprints of the innovation diffusion model are all over most attempts to promote the integration of instructional technology into the education process. The pro-innovation bias, the assumption of technological superiority that is the hallmark of the innovation diffusion model, is all too apparent in many instructional technology integration projects in the American school system. Often, huge investment is committed to upgrading technology infrastructure in schools on the erroneous assumption that if you install it, they will use it. Often forgotten are the human dimensions of the innovation adoption process, including the natural tendency of people to fear change, the need for investment in human capital development, and the requisite technical support needed to sustain the level of technology integration.

There are other challenges posed by the application of the innovation diffusion model to technology integration into the teaching-learning process, including the failure to decouple technology acquisition, often a corporate decision, from the decision to integrate, an individual choice. In other words while the decision to acquire technology is often taken at the high administrative level of local school and district leadership, the actual integration of the technology depends largely on the individual choices made by the classroom teachers. Additionally, the typical school architecture, which tends to isolate teachers in their different classrooms, often obscures the demonstration effect of technology. It is therefore possible to find highly technologically innovative teachers right next to teachers who are patently techno-phobic.

In his extensive review of the literature on the subject of instructional technology research, Surry (1997) identified the two broad theoretical frameworks of technological determinism versus technological instrumentalism as being the most important. According to Surry (page 5), technological determinists (also described as macro-theorists) view technology as an autonomous force, beyond direct human control, and as the prime cause of social change. Determinists (micro-theorists), on the other hand view technology only as a tool, largely under human control, and that can be used for either positive or negative purposes. A comparative analysis of the key characteristics of the two dominant theoretical frameworks is presented in table 1.

In order to capture the complexity of the variables impinging on the use of instructional technology by agricultural teachers in Florida, the study adopted a modified version of the Technology Triangle Model (Kemm, 2001). At the center of the Technology Triangle is the classroom teacher, whose decision whether or not to integrate technology into the teaching-learning process is dependent on the dynamic interaction among technological, human resource, and societal variables. Using this framework, the study included variables related to technology infrastructure, professional development, perception of relative advantage, and the respondents’ demographic characteristics in analyzing the level of technology integration by Florida’s secondary Agriscience teachers.
Table 1. Comparative Analysis of Technological Determinism Vs Instrumentalism

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<thead>
<tr>
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<th>Technological determinism</th>
<th>Technological instrumentalism</th>
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<tbody>
<tr>
<td>View of technology</td>
<td>Force for social change</td>
<td>As a tool</td>
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<tr>
<td>Source of social change</td>
<td>Technology</td>
<td>Human conditions &amp; aspirations</td>
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<td>Focus of theory</td>
<td>Institutional / systemic change</td>
<td>Needs of potential adopters</td>
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<td>Technological change</td>
<td>Revolutionary, in leaps</td>
<td>Slow, evolutionary</td>
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<td>Institutional reform</td>
<td>Top-down</td>
<td>Bottom-up</td>
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<td>Determinant of adoption</td>
<td>Technological superiority.</td>
<td>Human-technology interface</td>
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CLASSIC EXAMPLE


Hall & Ford (1987) Concern-Based Adoption Model

Adapted from Surry (1997). Diffusion Theory & Instructional Technology

Methods and Data Source

The study adopted a descriptive survey methodology. The Technology Triangle Model developed by (Kemm, 2001) was adapted and used as the conceptual framework in developing a survey instrument for data collection. The questionnaire was field-tested, reviewed, and validated using a sample of teachers in the Miami-Dade County Public School System. The target population for the study consisted of secondary agricultural teachers in the state of Florida. The data for the study was collected during the annual conference of the Florida Association for career and Technical Education (FACTE) in July 2004, in Tampa Florida. The FACTE Conference is unique in bringing together the broad spectrum of professional career and technical educators, including agricultural educators in the State. It was felt that attendance at the conference was broad and representative enough to reflect the true state of technology integration in secondary agricultural curriculum in the State. All the 55 teachers who attended the conference received the questionnaire to complete, however, only 45 respondents completed the survey, representing approximately 82% response rate. In order to validate the representativeness of the survey sample, an additional random sample of twenty non-conference attendees was selected from the Florida Agricultural Teacher Directory. There were no significant differences between the responses of the two sample frames. Data analysis for this study included descriptive statistics such as percentages, means, and standard deviation. Being a preliminary survey, it was felt that the more robust inferential statistics should be reserved for a more extensive study planned for the future.

Major Findings & Conclusions
This section presents the major findings of the study on teachers’ perceptions of the educational value of instructional technology, their level of technology integration, and the constraints they face in integrating technology into their programs. In order to gain a contextual understanding of the findings of the study it is important to describe the demographic characteristics of the respondents. As mentioned earlier the sample for the study consisted of Florida Agriscience teachers who attended the 2004 conference of the Florida Association for Career & Technical Educators (FACTE). While an effort was made to validate the representativeness of the sample of the entire teacher population, it bears mentioning that the sample probably represents the most professionally involved and innovative segment of the Florida Agricultural teacher population. In terms of their educational qualification, 36% had Bachelor degree, compared to 47% who possessed a master degree, 14% percent holding specialist degree, with the remaining 4% reporting holding doctorate degrees. When asked to rate their technology skills, 9% rated themselves beginners, 48% intermediate, 41% proficient and 4% advanced users. Sixty-four percent of the respondents were males, compared to 36% female.

In order to assess the perceptions of Florida Agriscience teachers about the educational value of instructional technology, they were presented with a set of likert-type questionnaire items, and asked to indicate their degree of agreement and disagreement. The result of data analysis on the research question is presented in table 2.

| Table 2. Teachers Perceptions about the Value of Instructional Technology |

Over 90% of respondents either agreed or strongly agreed with statements that technology enhances student learning (98%), teacher effectiveness (90%) and that schools have a responsibility to equip students with 21st century technology skills (98%). When asked whether the educational value of IT was often overrated only 2% strongly agreed while 10% agreed with the statement. Taken together, one can conclude that Florida Agriscience
teachers have very positive perceptions regarding the educational value of instructional technology. Similar findings based on anecdotal and survey data have been reported indicating that instructional technology has significant positive effect on student learning (Viadero, 1997; Bialo & Soloman, 1997).

In order to assess the degree to which Florida Agriculture teachers were integrating instructional technology into their programs, they were instructed to rate their frequency of use of different instructional technology. The data in table three present the findings related to the frequencies with which Florida Agriculture teachers integrated different instructional technology into their programs.

Respondents were presented with a set of commonly used instructional technology and instructed to indicate whether they used each technology three or more times per week (routine use), at least once a week (infusion), at least twice per grading period (exploration), never (non-users), or lack access to the technology (constrained potential users). An analysis of the graphic in table 3 clearly shows that a large majority of Florida Agriculture teachers routinely integrated or infused various instructional technologies into their curriculum. For instance, the following adoption rates were recorded: PowerPoint presentation (50%), word processing (78%), audio-visuals including video and television (95%), electronic grading (78%), requiring students to do internet research (48%), use of computer laboratory (43%), and teachers use of internet resource for planning and teaching (78%). However, the use of high-end instructional technology, such as having a course web page (21%), and engaging in online teaching (2%) is still low. Surprisingly, only a low percent of respondents indicated lack of access to technology as a constraint to integration. Zhao & Frank (2001) reported
similar high rates of technology integration in their study of technology use in Michigan schools.

However, since the data used for study relied on opportunistic sampling (teachers attending a technology conference) who are likely to be the most professionally involved and innovative, it would be interesting to find out if the same results can be replicated in a more representative random sampling of the entire population of Florida Agriscience teachers. Such a study is already in the pipeline.

Research question three deals with identifying the infrastructure, structural, professional development, institutional, and societal constraints hampering Florida Agricultural teachers from integrating technology into their curricula. Teachers were presented with a list of constraints to technology integration that have been reported in the literature. Respondents were instructed to rate on a 1-10 scale (1=no constraint, 5=medium and 10=most serious constraint) the degree to each constraint has hampered their abilities to integrate different technology. The result of the mean distribution and standard deviations analysis for the different constraints is presented in table 4. Based on the overall mean scores, one can conclude that Florida Agriscience teachers faced medium to low levels of constraints to their ability to integrate technology in their curriculum. The rankings of constraints indicate that teachers’ lack of the skills needed to troubleshoot routine computer crashes and breakdowns (mean score 5.67) received the highest ranking, followed in order by lack of school site facilities for repairs and technical support (mean score 5.5), students lack access to computers in their homes (5.09), and inadequate follow-up technical support by vendor (5.0). All other constraints received mean scores below 5.0.

In order to assess the sources and usefulness of technological training the teachers had received they were instructed to check the different sources of technology training they
had used during the 2003/2004 school year. They were also instructed to rate the usefulness of their overall technology training. The data presented in Table 5 show that the respondents have been exposed to different sources of technological training during the 2003/2004 academic year. Over 60% of the respondents indicated receiving technology training through their school districts, and 60% reported receiving in-school training. It is indeed significant that only 15% of the respondents reported taking college courses in technology integration compared to 60% who reported being self-taught. Also troubling is the fact that only 22% of respondents indicated receiving technological training from their professional colleagues. It is also ironic that the demonstrated efficacy of online learning as a tool for professional development is being grossly under-utilized, with only 15% of respondents indicating receiving professional development through online (elearning) sources. On the usefulness of overall training 18% of respondents rated their training very useful, 43% useful, 23% somewhat useful, with only about 16% rating their overall training of little use or useless. Hence, the respondents would appear to have substantially higher technology training than have been reported in other studies (Alonge, 2004; Boyd, 1997 and Zehr, 1997). It is therefore reasonable to assume that training played some part in the relatively high level of technology integration reported by the sample.

Table 5. Distribution of Respondents According to Access to Different Training Sources

![Bar chart showing distribution of respondents according to access to different training sources]

Conclusions

1. Teachers had very positive perceptions about the educational value of technology. Over 90% of the respondents either agreed or strongly agreed that technology enhances student achievement, and improves their effectiveness as teachers. This finding is counter-intuitive
to the general expectation that teachers would naturally resist the introduction an innovation, for which they had little training, and or familiarity.

2. Most of the respondents view themselves to be proficient in technology integration. Forty-eight percent of the teachers rated themselves intermediate in technology skills, while 41% regarded themselves as proficient.

3. Teachers in this sample reported a higher than normal rates of technology integration with 78% each reporting using word processing, electronic grading, and using internet in their planning and teaching. It appears however, that teachers were using computer as a productive-enhancing technology rather than as a tool for student exploration and learning.

4. What could be termed the “VCR effect” was clearly in evidence from the analysis of technology integration data. The level of technology integration was limited mainly to routine computer operations such as word processing, PowerPoint, use of emails, while the use of higher order computer applications, such as web page design, advanced multimedia application, computer-aided instruction (CAI), and other such student-driven computer applications were limited. The VCR effect was coined because like the experience with consumer use of the VCR, teachers were not taking full advantage of the installed capacity of technology to enhance the teaching-learning process.

5. On sources of professional development in technology integration used by teachers, it is significant that only 15% of the respondents reported training through college courses while close to 60% reported being self-taught. Also troubling and ironic at the same time is the fact that the demonstrated efficacy of online learning as a tool for delivering professional development courses is not being fully utilized. Only 15% of respondents indicated receiving online courses in technology integration. The bright spots in the analysis of data related to professional development activities in technology integration, is the finding that 60% of teachers reported receiving training through their school districts. Secondly, on usefulness of sources of technology training, 61% of respondents rated the sources of technological training they use as being either very useful or useful, 23% somewhat useful, and only about 16% rating their overall training of little use or useless.

6. Teachers rated the high cost of upgrading technology, poor training facilities, their lack of skills needed to troubleshoot routine computer crashes, and lack of access to home computers by their students as the constraints they face in integrating instructional technology into their curriculum.

7. Finally, the fact that teachers rated the lack of access to home computer by their students as constituting somewhat of a serious constraint would seem to indicate that while computers have become almost ubiquitous in our nation, the digital divide between the different socio-economic classes is still a painful reality.

Implications and Recommendations

Technology integration into the educational process is here to stay. Therefore as professional agricultural educators, members of the AIAEE have the responsibility to help
prepare teachers with the skills they would need to get our profession on the technology train. The imperatives of the technology-driven, highly competitive, global agricultural industry, coupled with the renewed emphasis on educational accountability, demand that agricultural education programs at all levels become dynamic, forward-looking, and progressive. Technology integration must be a key ingredient in this equation.

It is significant that secondary agricultural educators in Florida have very positive perceptions about the educational value of instructional technology and are in fact already integrating technology into their curriculum. This finding represents great opportunity for departments of agricultural education in our universities to capitalize on by strengthening both their pre-service and post-graduation professional development programs in instructional technology integration.

While, there has been significant stride in the use of distance education and online teaching in our universities, the fact that only 15% of the respondents reported using online learning, would indicate that much needed to be done either in expanding our installed capacity to deliver online courses or do a better job of marketing them to our teachers. In the same vein, the fact that inadequate pre-service training in technology integration coupled with the fact that a low percent of respondents indicated taking college courses in instructional technology, portend great implications for teacher education programs. Teacher education programs must do a better job of incorporating courses in instructional technology use in their curriculum offerings. There are already signs that many agricultural teacher education programs are already integrating courses in instructional technology, however more still needs to be done in this area.

It is recommended that more research is needed to assess the level of technology integration into agricultural education programs at all levels. Specifically, we need to develop better instruments to assess, in specific terms, how integrating instructional technology enhances student learning. This study represents a preliminary step in assessing the level of technology integration into secondary agricultural education program in Florida. A more definitive and inclusive study covering a broader-based sample is already in the planning stage.

Finally, the study clearly demonstrates that technology integration is not merely a simple case of putting computers in the classroom and hope that teachers use them. Teachers will only use instructional technology if they have the needed hardware and software, the skills and knowledge necessary to integrate technology, receive continuous professional development upgrades, and receive the needed technical support to fix hardware and software problems that are synonymous with technology use. Hence, current simplistic, technological deterministic approaches to technology integration, which tend to focus mainly on upgrading technological infrastructure, without a concomitant investment in areas such as professional development and technology support, are likely to achieve limited success. More inclusive, multidimensional, and holistic approaches to promoting the integration of instruction technology are needed. Perhaps the greatest challenge to technology integration is the high rate of technological obsolescence, and the resultant high cost of constantly upgrading and updating schools’ technology infrastructure.
Reference


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