Journal of Agricultural Education
Volume 34, Number 4, pp. 46-54
DOI: 10.5032/jae.1993.04046

Using the Innovation Adoption Diffusion Model to Target Educational Programming

Timothy Rollins, Assistant Professor
The Pennsylvania State University

The adoption of new ideas and practices is affected by at least five factors: 1) the type of decision involved in adoption; 2) perceived attributes of the innovation; 3) communication channels used; 4) nature of the client system; and 5) the extent of the practitioner's effort (Lamble, 1984). A major function of extension practitioners is to facilitate the adoption of new ideas and practices or to influence the rate of diffusion and adoption of innovations by their clients. To enhance their effectiveness as change agents, extension practitioners must understand the unique characteristics that describe their clientele system.

Two decades ago, Rogers and Shoemaker (1971) conducted research on adopter characteristics to enable diffusion agencies (i.e. Cooperative Extension) to appropriately categorize and address adopter audiences. They analyzed publications and summarized hundreds of empirical diffusion studies that either supported or did not support more than four dozen generalizations about technology adoption. Their findings related various independent variables to innovativeness (dependent variable) that were then grouped into three categories of generalizations: 1) socioeconomic status; 2) personality variables; and 3) communication behavior. For example, a socioeconomic generalization states that earlier adopters are no different from later adopters in age; a personality generalization states that earlier adopters have greater empathy than later adopters; and the communication behavior of an earlier adopter includes more contact with change agents than that of a later adopter. Rogers' and Shoemaker's research produced five categories of adopters based upon innovativeness: laggards, late and early majority adopters, early adopters, and innovators.

Although Reddy (1987) identified personal factors, such as age and education, that contribute to the adoption of technology, it was Rogers (1962) who earlier recognized that people do not adopt innovations simultaneously:

> *Innovators* are "venturesome..., eager to try new ideas . . .,desir[ing] the risky . . ., cosmopolites". *Early adopters* are "respected by [their] peers . . ., more integrated [into] the local social system . . ., opinion leader[s] . . ., localities". The *early majority* "interact frequently with their peers [and] . . . may deliberate for some time before completely adopting a new idea . . . and follow with deliberate willingness in adopting innovations, but seldom lead." "The *late majority* adopt new ideas just after the average member of a social system, . . . [are] skeptical, and...the pressure of peers is necessary to motivate adoption." *Laggards* adopt innovation last,...are traditional and "tend to be frankly suspicious of innovations and change agents. . . The laggard's attention is fixed on the rear-view mirror." (pp. 248-250)

Rogers and Shoemaker (1971) defined innovativeness as "the degree to which an individual is relatively earlier in adopting new ideas than other members of his social system" (p. 27). Innovativeness can also be used to classify people into adopter categories because it is a continuous variable that can be partitioned into discrete categories that are *exhaustive* (include all respondents of the sample), that are *mutually exclusive* to exclude respondents from other categories, and can be derived from one *classification principle* (Rogers, 1962).

Historically, the transfer of technology from a laboratory to a field has been a significant challenge for extension. The failure to recognize and address the psycho social component of technology adoption as part of the educational process has served to illustrate that generating knowledge is not always synonymous with diffusing and adopting knowledge (Barao, 1992). Riesenberg and Gor (1989) found that knowing farmers' preferences for receiving information would help program planners transfer information about innovative farming practices more effectively. In order to be an effective channel for the diffusion of information, change agents must be aware of their clients' innovativeness.

Purpose and Objectives

One of the goals of social science is to provide an empirical base for understanding human behavior. The empirical prediction of behavior is not meaningful unless it is theoretically based and logically consistent. This study sought to determine which of fifteen generalizations (five from each of the three categories) selected from those studied by Rogers and Shoemaker (1971) were related to Pennsylvania farm operators' perceptions of their innovativeness. Could these generalizations be used to profile the different categories of adopters? The study was guided by the following research questions:

How do Pennsylvania farm operators perceive their innovativeness?

Which variables derived from Rogers' and Shoemaker's generalizations about innovativeness most accurately classify Pennsylvania farm operators?

Procedures

A descriptive correlational study was used to examine the nature and strength of the relationships between fifteen of the generalizations derived from Rogers' and Shoemaker's generalizations about innovativeness--socioeconomic status, personality, and communication behavior. The population frame consisted of 24,546 Pennsylvania farm operators whose unduplicated names and mailing addresses appeared on the Pennsylvania Department of Agriculture pesticide training or brucellosis test lists. It was determined from Oliver, Hinkle, and Hinkle (1983, 1985) that the minimum sample size should be 197 respondents based upon the a priori effect size (.10) and a .05 alpha. A computer-generated table of random numbers was used to select the initial random sample of farm operators whose telephone numbers were subsequently located in telephone directories at the Pennsylvania State University library. Farm operators were considered a "non-contact" and removed from the initial sample if their telephone number was unlisted or inaccurately listed in the telephone directory, or after three unsuccessful attempts (no

answer, unavailable, or not at home) to contact them during weekdays from 7:30 a.m. until 9 p.m. (Frey, 1989). The random selection procedure was reiterated on two subsequent occasions (400 additional names and telephone numbers) to secure the minimum sample.

Two additional interviewers were trained by the researcher to implement the research protocol (telephone interview). The average length of time to conduct the telephone interview and secure the necessary information averaged eight minutes. All respondents were guaranteed anonymity and confidentiality of their answers. The total number of farm operators who were successfully contacted and asked to participate in the study totaled 279. Two hundred farm operators (72%) responded to the telephone survey that was conducted during the fall of 1991.

Instrumentation

An Adopter Characteristics Questionnaire was developed from generalizations about innovativeness (Rogers & Shoemaker, 1971). It was comprised of fifteen attitudinal statements positively correlated with innovativeness. The first of two parts consisted of nine questions with a 5-point, Likert-type scale that required farm operators to rate the following variables (1=never, 5=all the time): Business Travel; Control of Future; Empathy; Use of Person for Information; Use of Printed Material; Risks; Social Travel; Use of Extension; and Use of Personnel. The second part consists of six questions with a 5=point Likert-type scale that required farm operators to rate the following variables (1=not important, 5=very important): New Concepts and Ideas; Credit; Education; Learn New Practices; Positive Changes; and Scientific Research. Three additional demographic questions produced the variables: Years of Education, Acres Farmed, and Age of the Respondent.

Content and face validity of the questionnaire were established by a panel of experts consisting of faculty and graduate students from the Department of Agricultural and Extension Education at The Pennsylvania State University. The Adopter Characteristics Questionnaire was field tested with three farm operators selected from the population prior to selection of the initial sample. Based upon their responses and comments from the department faculty and staff, the questionnaire was modified. The 15 attitudinal items were subjected to a Cronbach's reliability test post hoc yielding an alpha coefficient of .73 which allowed a summated index called "adopter score" that measured general attitudes toward adoption of innovations.

Results

Ages of the Pennsylvania farm operators in this sample ranged from 19 to 76 years with a mean of almost 48 years (47.8). As a representative sample, they farmed an average of slightly more than 200 acres which is higher than the state average farm size (153 acres).

The findings are presented in order of the two research questions posed for this study.

Research Question One

Figure 1 (adapted from Rogers and Shoemaker, 1971, p. 182) uses the mean and standard deviation to divide the normal adopter distribution into the five adopter categories: innovators, early adopters, early majority, late majority, and laggards. Figure 1 graphically reveals the distribution of 183 Pennsylvania farm operators based on their responses to the Adopter Characteristics Questionnaire. Twenty-one (11%) farm operators had adopter scores ranging from 23 to 41 (laggards) while 68 (37%) farm operators' adopter scores ranged from 42 through 49, classifying them as late majority adopters. Farm operators who were classified as early majority adopters numbered 61 (33%) and had adopter scores ranging from 50 to 56 while 33 (18%) farm operators who were classified as early adopters had scores ranging from 57 to 61. No farm operators in this sample were classified innovators as described in the theory.

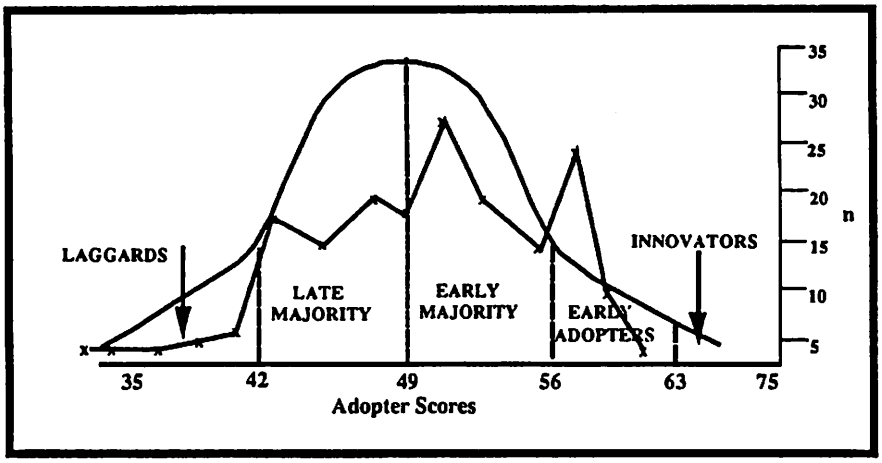

Figure 1. Distribution of Adopter Categories and Pennsylvania Farm Operators

Research Question Two

Discriminant analysis was used to identify relationships between the four adopter categories defined in this study (no innovators were revealed) and the quantitative predictor variables from the Adopter Characteristics Questionnaire. Two approaches were used for variable selection in the discriminant analyses. Direct-entry simultaneously forced variables into the discriminant analysis providing they satisfied the tolerance criterion (alpha = .05). The Wilks' method entered and removed variables one at a time on the basis of minimizing the overall Wilks' lambda. Examination of correlation matrices determined that no discriminating variables were linear combinations of other discriminating variables.

Table 1 reveals fifteen variables correctly classified 92 percent of the respondents (183) into one of four adopter groups--early adopter, early majority or late majority adopters, and laggards. Laggards were correctly classified in almost 90 percent of the cases (34/38)

while 95 percent of the late majority adopters (61/64) were correctly classified. Almost 89 percent (55/62) of the early majority adopters were correctly classified while 100 percent of early adopters (19) were classified correctly. The discriminant analysis (Wilks' method) yielded a canonical correlation of .92 which explained 83 percent of the variance in classifying farm operators into the adopter groups.

Table 1. Multiple Discriminant Model to Classify Pennsylvania Farm Operators' Innovativeness

Function Derived	Eigenvalue	Canonical R	Wilks Lambda	Chi Square	df	Sig.
Innovativeness	5.24	.92	.135	329.13	45	<0.00
Variables Comprising Discriminant Function		F to Enter	Wilks Lambda		Standardized Discriminant Coefficient	
Scientific Research		32.1	.64		.25	
New Concepts and Ideas		22.6	.51		.21	
Use of Personnel		19.2	.43		.20	
Empathy		17.0	.37		.42	
Social Travel		15.5	.33		.38	
Use of Extension		14.6	.29		.41	
Importance of Education		13.8	.25		.42	
Risks		13.3	.23		.40	
Credit		12.7	.21		.35	
Control of Future		12.1	.19		.35	
Use Person for Information		11.7	.17		.33	
Business Travel		11.4	.16		.37	
Positive Changes		11.0	.15		.29	
Learn New Practices		10.5	.14		.29	
Printed Material		10.0	.13		.19	

*p<.05, df = 1, 172.

Data presented in Table 2 reports five variables that discriminated 100 percent (19) of the innovators from 133 farmers (81%) classified as early and late majority adopters and laggards. The model correctly classified 83 percent of the respondents and accounted for 19 percent of the variance in discriminating between early adopters and farmers classified in the three other categories.

Table 2. Discriminant Model for Early Adopters Compared to Other Farm operators

Function Derived	Eigenvalue	Canonical R	Wilks Lambda	Chi Square	df	Sig.
Innovativeness	0.25	.44	.80	39.34	5	<0.00
Variables Comprising Discriminant Function		F to Enter*	Wilks Lambda		Standardized Discriminant Coefficient	
Use of Extension		12.1	.89		.59	
Empathy		6.2	.85		.41	
Business Travel		3.9	.83		.33	
Use of Personnel		3.0	.81		.30	
Control of Future		2.7	.80		.28	

*p<.05, df = 1, 182.

Table 3 reports the results of a discriminant analysis to determine whether a discriminant function provided differentiation between the combined adopter categories of early adopters and early majority adopters compared to late majority adopters and laggards. Using direct-entry, six variables--scientific research positive changes, new concepts and ideas, use of personnel, empathy, credit, and business travel--correctly classified 89 percent of the innovators and early majority adopters from late majority adopters and laggards. Ninety-six percent of the combined group (81) of early adopters and early majority adopters were correctly classified compared to 83 percent of the combined group of late majority adopters and laggards (102). The model yielded a canonical correlation of .74 and explained 55 percent of the variance in discriminating between these two groups, early adopters and early majority adopters, and late majority and laggards.

Table 3. Discriminant Model for Early Adopters and Early Majority Adopters Compared to Late Majority Adopters and Laggards

Function Derived	Eigenvalue	Canonical R	Wilks Lambda	Chi-Square	df	Sig.
Innovativeness	1.24	.74	.45	142.96	7	<0.00
Variables Comprising Discriminant Function		F to Enter*	Wilks Lambda			Standardized Discriminant Coefficient
Scientific Research		67.6	.73			.43
Use of Personnel		54.2	.62			.46
Positive Changes		46.2	.56			.32
Empathy		41.4	.52			.39
Business Travel		37.6	.48			.33
Credit		34.1	.46			.26
New Concepts and Ideas		30.9	.45			.27

*p<.05, df = 1, 180.

Table 4 reports six variables--social travel, importance of education, use of personnel, credit, use person for information, and business travel--correctly classified 89

Table 4. Discriminant Model for Laggards Compared to Other Farm Operators

Function Derived	Eigenvalue	Canonical R	Wilks Lambda	Chi-Square	df	Sig.
Innovativeness	.80	.67	.55	105.05	6	<0.00
Variables Comprising Discriminant Function		F to Enter*	Wilks Lambda			Standardized Discriminant Coefficient
Social Travel		30.5	.86			.48
Importance of Education		31.4	.74			.58
Use of Personnel		33.3	.64			.43
Credit		29.4	.60			.36
Use Person for Information		26.4	.57			.38
Business Travel		23.6	.55			.30

*p<.05, df = 1, 182.

percent of the laggards compared to the combined group comprised of early adopters and early and late majority adopters. Thirty-four of 38 respondents were correctly classified as laggards while 129 (89%) of the respondents were classified in the other group comprised of early adopters and early and late majority adopters which yielded a total of 89 percent correct classification for the model. The discriminant function yielded a canonical correlation of .67 that explained 45 percent of the variance.

Discussion

The respondents in this study can be characterized similarly to what Rogers and Shoemaker (1971) predicted when they described the continuum of innovativeness on the basis of two characteristics of a normal distribution, the mean and the standard deviation. Based upon scores from the Adopter Characteristics Questionnaire, 52 percent of the farm operators were classified as early adopters and early majority adopters and 48 percent were late majority adopters and laggards.

The first discriminant model developed for each of the four categories of adopters in this study correctly classified more than nine of every ten respondents and utilized fifteen variables. Three variables--the importance of scientific research,k new concepts and ideas, and the frequency of use of personnel--alone explained 57 percent of the variance. Despite additional discriminant models that categorized adopters using fewer variables from the Adopter Characteristics Questionnaire, none of the models proved to be more accurate classifying adopters and none explained as much of the variance associated with innovativeness.

In the second discriminant model, the frequency of farm operators' use of extension, business travel, use of person for information, empathy, and control over the future discriminated 100 percent of the early adopters from the other combined groups of adopters. The first three variables were derived from Rogers' and Shoemaker's (1971) category of generalizations dealing with communication behavior; the latter two were associated with personality.

The third model discriminated early majority adopters from the late majority adopters and laggards by seven variables: importance placed in scientific research, credit, new concepts and ideas, and making positive changes, as well as the frequency with which they used personnel from companies or agencies, traveled for business purposes, or empathized. Importance of credit was derived from a socio-economic generalization; three of each of the six remaining variables were derived from generalizations associated with communication behavior and personality.

The frequency of use of personnel from companies or agencies, getting information from people, travel for business or social purposes, and importance of education and credit correctly classified laggards in nine out of ten cases (89%). The latter two variables were derived from socio-economic generalizations, the other variables with respondents' communication behavior.

Implications and Recommendations

This study confirmed that Rogers' and Shoemaker's (1971) generalizations about innovativeness are still useful to profile categories of adopters among the respondents. Despite the fact that no one set or group of independent variables repeatedly classified their innovativeness across the spectrum, these results can provide keen insights into techniques practitioners need to provide education and information about new technology to farmers.

According to their theory, if agents desired to pinpoint educational programming to have the greatest impact in implementing new fertilization practices to improve water quality in their realm of influence, they should seek out innovators or early adopters to provide necessary leadership. What traits ideally and accurately characterize these individuals? In this study, over two-thirds of the explained variability (69%) in classifying farm operators into one of the four categories of adopters was accounted for by three variables: 1) importance of scientific research; 2) learning about new concepts and ideas; and 3) the frequency with which they used personnel from other agencies and companies--besides Cooperative Extension. Fifteen of the generalizations previously provided by Rogers and Shoemaker are validated in this study. The potential still exists for educators to use these, and other generalizations, to maximize their effectiveness in facilitating the adoption of new ideas and practices by their clients.

This study also confirmed that not all potential adopters of new technology use one information source exclusively. There are, in fact, a multitude of information sources available for farmers to utilize other than extension. Individuals adopting new technology or practices go through five identifiable steps--awareness-interest-evaluation-trial-adoption--that have preferred information sources associated with each of them (Lionberger & Gwin, 1982). Innovators, who are the first to try new things, may provide local trials for others to see after they have read technical and research publications. In other words, some programs should be designed for specific audiences to inform or provide an awareness of the technology, while others should be designed to focus on generating interest in or for evaluating the technology.

Scientific laboratories, such as those found in industrial and research parks, agribusiness and agrichemical corporations, and biotechnology agencies have become purveyors of the types of technology, services, and information that, until recently, had been almost exclusively within extension's domain. Effective change agents can use the information from this study to target both cooperators and collaborators, as well as prospective clientele, who may not have been previously identified.

References

Barao, S.M. (1992). Behavioral aspects of technology adoption. Journal of Extension, 30(2), 13-15.

Frey, J.H. (1989). Survey research by telephone. New York: Sage Publications.

Lamble, W. (1984). Diffusion and adoption of innovations. In Donald J. Blackburn (Ed.), Extension handbook (pp. 32-41). Ontario: University of Guelph.

Lionberger, H.F. & Gwin, P.H. Communication strategies: A guide for agricultural change agents. Danville, IL: The Interstate Printers and Publishers, Inc.

Oliver, J.D., Hinkle, D.E., & Hinkle, C.A. (1983). How large should the sample be? A question with no simple answer? Or . . . Educational Psychological Measurement. 43(4), 1051-1060.

Oliver, J.D., Hinkle, D.E., & Hinkle, C.A. (1985). How large should the sample be? Part II-The one sample case for survey research. Educational and Psychological Measurement, 45(1), 271-280.

Reddy, A.A. (1987). Adoption and diffusion of farm information. In Extension Education (pp. 277-292). Batpatla, India: Sree Lakshmi Press.

Riesenberg, L.E. & Gor, C.O. (1989). Farmers' preferences for methods of receiving information on new or innovative farming practices. Journal of Agricultural Education, 30(3), 7-13.

Rogers, E.M. (1962). Diffusion of innovations. New York: The Free Press.

Rogers, E.M. & Shoemaker, F.F. (1971). Communication of innovations: A cross-cultural approach. New York: The Free Press.