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ABSTRACT

The roles of perceptions in instructional development and adoption processes were studied with regard to the attributes of three computer-based learning modules designed for use in weather-forecasting agencies as on-site training for forecasters. Twenty-nine forecasters were the potential adoption group studied as intended end-users. Seven instructional developers who had worked on the design and development of the modules were interviewed about their perceptions. In addition, 32 forecasters completed questionnaires about the modules. Developers tended to discuss the modules in terms of how they fit into the overall weather-forecasting organization, seeming to view the agencies as the potential adopters. Compatibility, complexity, and relative advantage were important perceptions in a forecaster's decision to adopt the learning modules, but the ability to conduct trials or observe results did not emerge as important perceptions for adopters. Implications for the adoption of technology are considered. Two figures and two tables illustrate the discussion. (Contains 24 references.) (SLD)

Title:

The Role of Perceptions in Instructional Development and Adoption

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The purpose of this paper is to report the results of a study that examined the role of perceptions in the instructional development and adoption process. According to the theories developed by Rogers (1983), if potential adopters have favorable perceptions of an innovation's attributes, then they are more likely to adopt the innovation. Many researchers (e.g., Clinton, 1972; Kivlin, 1960; Weinstein, 1986; Wyner, 1974) have examined the role that perceptions play in the adoption of an innovation. The present study was unique because it examined not only the role of perceptions in the adoption of an innovation, but also the role that perceptions played in the development of the innovation.

The attributes of an innovation are the basis upon which potential adopters form their perceptions of the innovation (Rogers, 1983). According to Rogers, all innovations can be thought of as having five general attributes. These attributes are relative advantage, complexity, compatibility, observability, and trialability. This study examined the perceptions of potential adopters and instructional developers in regard to the attributes of three computer-based learning modules. In addition, the role that perceptions played in the development and adoption of the modules was examined.

Statement of the Problem

Many of the products and practices of instructional technology have failed to make a major impact on education. Burkman (1987) writes that many endeavors that use the research-development-diffusion (RDD) paradigm suffer from a lack of utilization. Instructional technology is an endeavor that makes extensive use of the RDD paradigm. Burkman (1987) writes that instructional technology has experienced a lack of utilization in all fields, including primary and secondary schools, colleges and universities, and even in industry and the military. One reason for this lack of utilization could be that instructional developers do not understand and account for the perceptions of potential adopters during the development process. Referring to educational technologists in general, Dalton (1989) writes that "although we can fill instructional gaps with fervor, we never seem to examine our solutions in light of the wants of the implementors" (p. 22). Instructional developers commonly believe that products which result in more "effective and efficient" instruction will automatically be attractive to potential adopters (Burkman, 1987). Ralph W. Tyler (1980) writes "many developers of technology accept the view that as time passes, there will be increasing use of the innovation until it has become a common element in school practice" (p. 11). From these statements, we can see that many developers have the assumption that if they develop more effective instruction, adoption and diffusion will follow in time. This might be a false assumption.

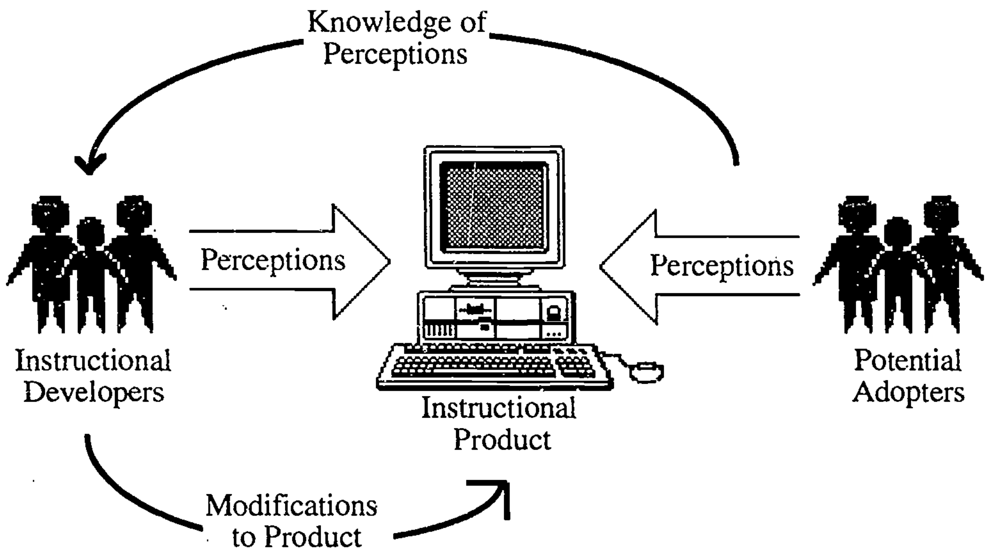

Figure 1. A model showing how knowledge of perceptions can affect development of a product.

Burkman (1987) feels a more user-oriented approach to instructional development is needed to increase utilization. He also believes that, as part of this user-oriented approach, instructional developers must seek to understand and positively manipulate the perceptions of potential adopters in regard to the attributes outlined by Rogers (1983). A more user-oriented approach, one that seeks to understand and take into account the wants of the implementors, might lead to the increased use of instructional innovations.

Figure 1 is a model showing how knowledge of the perceptions of potential adopters might result in modifications to an instructional product. These modifications, in turn, might lead to changes in the perceptions of potential adopters in regard to the product. This process of development, knowledge gaining, and modification would result in the circular model depicted in Figure 1. The use of such a model by instructional developers could lead to the increased adoption and use of their instructional products

The Adoption Situation in This Study

The study described here was part of a larger evaluation study of three multi-media computer-based learning (CBL) modules. The three multi-media, CBL modules were developed for use in three weather forecasting agencies. The modules represent the first in a series of twenty-one modules to be developed for the agencies. The modules are to be used as on-site training for operational forecasters at multiple sites in each of the three agencies. The computer delivery method and the independent study provide enhanced opportunities for realistic study of forecasting knowledge and skills. The modules are an innovative method of training offered on-site to weather forecasters. The purpose of the overall evaluation was to determine how the content, strategies, procedures, and implementation of the modules might be modified to enhance cognitive and affective outcomes. Information gathered in the evaluation of the first three modules will be used to inform the design of succeeding modules.

The adoption situation examined in this study is somewhat unique because there were two groups of potential adopters. The operational forecasters in the field who will use the modules were one group of potential adopters. The organizations that commissioned the production of the modules were also a group of potential adopters. In order for the CBL modules to be fully utilized, it was necessary for both groups to adopt the modules. The forecasting organizations, for their part, had to commission production of the modules, accept delivery of the finished products, make the completed modules available at the field sites, and encourage their forecasters to use the modules. The individual forecasters, for their part, had to routinely use the modules, devote time and effort to studying the modules, and incorporate the CBL modules into the daily work environment of the forecasting sites. Either the organizations or the forecasters could have prevented the adoption and full utilization of the modules by failing to perform the activities listed above.

For purposes of this study, the forecasters were the potential adopter group whose perceptions were examined by the researcher. The forecasters were selected for study because they were the intended end users of the modules. Examining the perceptions of the end users linked the present study more directly to Burkman's (1987) theory that a more user-oriented approach to instructional development could increase adoption of the innovation.

Research Questions

This study sought to answer four research questions:

1) What were the perceptions of instructional developers in regard to relative advantage, complexity, compatibility, trialability, and observability during the development of the computer-based learning modules?

2) What were the perceptions of potential adopters in regard to the relative advantage, complexity, compatibility, trialability, and observability of the computer-based learning modules?

3) If instructional developers were aware of the perceptions of potential adopters, how did that awareness affect the development of the modules?

4) How did the perceptions of instructional developers and potential adopters compare in regard to the relative advantage, complexity, compatibility, trialability, and observability of the computer-based learning modules?

Limitations of the Study

There are two key limitations to this study. The first limitation is that this study did not attempt to determine the importance of perceptions relative to other factors which influence adoption. Rogers and Shoemaker (1971) write that five variables influence an innovation's rate of adoption These variables are perceived attributes, type of innovation-decision, communication channels, nature of the social system, and the extent of the change agents' promotion efforts. The present study examined only the perceived attributes of the innovation.

The second key limitation of this study is that this study did not attempt to determine how perceptions influenced the long-term retention of the modules after their adoption. As Burkman (1987) points out, while the decision to adopt an innovation is based, in part, on subjective perceptions, "once an innovation has been adopted . . . perception tends to be displaced by reality." This study was concerned with how perceptions affected the initial decision (i.e., adoption or non-adoption).

Review of the Literature

This study is based upon two key literature sources. The first, and primary source, is E.M. Rogers' writings related to the communication and diffusion of innovations. Chief among these writings are Rogers (1983) *Diffusion of Innovations* (3rd edition) and Rogers and Shoemaker (1971) *Communication of Innovations: A Cross-Cultural Approach* (2nd edition). These books provide the theoretical basis for many of the studies cited in this review, especially those studies primarily concerned with the perceived attributes of an innovation.

The second literature source upon which this study is based is Ernest Burkman's (1987) chapter entitled "Factors Affecting Utilization" that appears in *Instructional Technology: Foundations* (Gagné, 1987). In this chapter, Burkman calls for a more user-oriented approach to instructional design. Part of this new approach calls for instructional designers to determine the attributes most important to potential adopters and, based upon that knowledge, to design products that present positive perceptions of those attributes (Burkman, 1987).

Research Related to Perceived Attributes

Hurt and Hibbard (1989) write that "it is well-documented in the diffusion research that the characteristics of innovations as perceived by potential adopters play a critical role on the rate of acceleration of the adoption curve" (p. 214). Many studies of perceived attributes have been based directly on Rogers' theory of perceived attributes. A variety of fields, ranging from agriculture to sociology, are represented by these studies.

The first large-scale studies to examine the relationship between perceptions and an innovation's rate of adoption took place in the early 1960s. The chief investigators of the relationship at that time were Joseph Kivlin and Frederick Fliegel. Kivlin's (1960) study of the perceptions of farmers in Pennsylvania in regard to numerous agricultural innovations is the earliest exploration of perceived attributes found in the literature. Although this study predated Rogers' theory, Kivlin's attributes are largely analogous to the attributes developed Rogers.

Kivlin found that relative advantage, complexity, and mechanical attraction were the attributes most significantly related to adoption for the Pennsylvania farmers. Also in this study, Kivlin determined that the characteristics of an innovation accounted for 51% of the variability in rate of adoption. Kivlin's (1960) study presents the strongest and earliest-found evidence that the assumption which underlies the present study is valid.

In 1966, Fliegel and Kivlin studied the perceptions of the same 229 farmers as Kivlin's 1960 study. In the 1966 study, Fliegel and Kivlin found that trialability was the most significant attribute related to adoption. Relative advantage, one of the most significant attributes in the earlier study, emerged as the second most significant attribute in the 1966 study.

Kivlin and Fliegel (1967a) also studied the different perceptions that small-scale farmers and middle-scale farmers had in regard to various agricultural innovations. They found that small-scale farmers were slower to adopt new practices than were the middle-scale farmers. The researchers concluded that the difference in the rate of adoption was not only a "function of production scale but also . . . a result of differences in perceptions" (p. 90). Kivlin and Fliegel's (1967a) study is important because it is the first example of a study concluding that differences in the perceptions of two groups account, in part, for differences in rate of adoption. Another study by Kivlin and Fliegel during this period (1967b) also found that relative advantage was the most influential attribute related to rate of adoption.

Gurmeet Singh Sekhon (1968) studied perceptions of farm innovations in Punjab, India. The population for Sekhon's study was made up of professional advocates of an innovation and their clients. Clients were divided into those who had a high degree of contact with the professional advocates, and those who had low contact. Sekhon hypothesized that professional advocates and their high contact clients would share similar perceptions of innovations. Sekhon found, however, that the two groups had highly dissimilar perceptions. The results of Sekhon's study are similar to the results of Ross' (1983) study. Ross discovered that change agents and non adopters in his study shared perceptions which were more similar than the perceptions shared by change agents and adopters. It is possible to hypothesize, in view of the studies by Sekhon and Ross, change agents and potential adopters do not have to share similar perceptions in order for an innovation to be adopted.

Clinton (1972) studied the role that perceived attributes played in the acceptance of innovations by 337 teachers in Canada. He found that teachers categorized innovations according to the attributes they perceived and that the actual acceptance of the innovation depended upon the perceived attributes. Clinton arrived at two major conclusions. The first was that how teachers perceived an innovation was as important as the innovation itself. The second was that innovation is, during its early stages, a mental process not a physical act.

In 1974, two studies (Wyner; Hahn) that examined the theory of perceived attributes were published. Wyner (1974) used attributes to study teachers' perceptions in regard to an educational innovation in an elementary school. She concluded that the perceptions of those who use an innovation can provide valuable data to change agents. Hahn (1974) studied the perceptions of over 200 high school teachers in regard to educational innovations. Observability was the attribute that was most significantly related to the adoption of an innovation in Hahn's study. Hahn's conclusion is fairly unique because no other study located in this review of the diffusion literature found observability to be the primary attribute related to adoption.

Keeler (1976) and Holloway (1977) published studies related to perceived attributes in the middle 1970s. Keeler studied how to increase the rate of adoption of a solar energy product. He hypothesized that a better understanding of the perceived attributes held by potential adopters in regard to the product would aid in the development of effective marketing strategies. Holloway studied the perceptions of high school principals in regard to an educational innovation. He found that relative advantage and compatibility were the attributes most influential in the principals' adoption decisions. Holloway's results are similar to Moallemian (1984) who found that perceptions of relative advantage and trialability had significant influence upon the innovation's rate of adoption.

Allan and Wolf (1978) analyzed the perceptions of 100 innovative educators. Their study suggests that the attributes of Rogers and Shoemaker (1971) may not be applicable to educational settings. Allan and Wolf found that only complexity had a significant influence on the likely adoption of educational innovations. That is, the less complex an innovation is perceived to be, the more likely that innovation is to be adopted. They conclude by writing: "Results of this investigation . . . suggested innovation attributes selected for study provided marginal insight into adoption of educational innovations" (p. 336).

Rogers, Daley, and Wu (1982) studied the diffusion of home computers. They determined that perceptions of relative advantage, compatibility, observability, and trialability were important, positive influences on their subjects' adoption decisions. Complexity and cost were found to be important, negative factors in the adoption decisions. That is, the more complex and expensive computers were perceived to be, the less likely they were to be adopted.

Eads (1984) used a unique method to examine how perceived attributes might influence the rate of adoption of an educational innovation. While most such studies have employed questionnaires and interviews in an ex post facto design, Eads used written descriptions of the innovation's attributes. In all, thirty two sets of descriptions were used to encompass all possible combinations of favorable and unfavorable attributes. Students, teachers, and administrators were included in the study. Respondents were asked to rate each description set using a semantic differential scale. Eads discovered that compatibility was the most influential attribute for students and administrators. No influential attribute emerged for the teacher group.

In 1985, Dozier examined how the perceived attributes of electronic text might influence the diffusion and adoption of that innovation. Dozier writes, based on his own review of the literature, that "prior research indicates that perceived attributes are powerful predictors of adoption" (p.18). He hints that electronic text could offer faculty members "significant relative advantages over conventional methods of scholarship" (p. 60). He adds that perceived attributes of an innovation "particularly its relative advantage, provide the energy needed to overcome thresholds or barriers to adoption" (p. 49).

Two studies published in 1986 (Kehr; Weinstein) examined the role that perceptions played in the adoption and diffusion of educational innovations. Kehr studied the diffusion of personal computers among 412 full-time faculty members in college level business administration and teacher education programs. He found that the groups shared similar judgments in regard to the adoption of personal computers. Cost was the most important consideration for both groups, followed by the perceived attributes of the product. Weinstein studied the perceptions of civilian and military educators. The subjects for this study were 244 public school teachers in Florida and 397 educators in the U.S. Marine Corps. He found that, for both groups, the attributes of relative advantage, trialability, compatibility, and observability were positively correlated with adoption, while the attribute of complexity was negatively correlated. Weinstein concluded that perceptions play an important role in the adoption decisions of both military and civilian educators.

Norris and Briers (1988) studied how agricultural science teachers in Texas perceived a proposed change in the curriculum. Their study is different from the others included in this review because Norris and Briers looked at perceptions in regard to the *change process*, not in regard to a specific product. The sample for their study was 933 teachers who were attending an agricultural science convention. Norris and Briers found that perceptions of the change process were the best predictor of a teacher's choice to adopt or reject the changes. They also found, however, that only 16% of the adoption or rejection of the changes could be explained by a teacher's choice. Other factors accounted for most of the variance in the adoption or rejection decision process.

Rogers' Model of Innovation Diffusion

The model described by E.M. Rogers is the most comprehensive model of innovation diffusion discovered in this review of the literature. Rogers explains his theories in two editions of a book. These editions are Rogers (1983) *Diffusion of Innovations* (3rd edition) and Rogers and Shoemaker (1971) *Communication of Innovations: A Cross-Cultural Approach* (2nd edition). These two books, containing slightly different material, outline the basic theories of diffusion and state hypotheses related to rate of adoption.

Rogers and Shoemaker's (1971) *Communication of Innovations: A Cross-Cultural Approach* (2nd edition.) is important for two reasons. The first reason, mentioned above, is its large bibliography cross-referenced by each of 103 generalizations. The second reason is that it is among the first works to comprehensively discuss the many factors which influence an innovation's rate of adoption.

Rogers' (1983) *Diffusion of Innovations* is important to the current study because it presents an informative account of the process of innovation development. Rogers, in *Diffusion of Innovations*, is the first author found by this review to state that pre-diffusion activities, such as development, play an important role in the diffusion of an innovation. The general premise of the present study, that instructional developers can take actions to identify and account for the perceptions of potential adopters during the development of an instructional innovation and, as a result enhance the subsequent adoption of the innovation, is based upon Rogers' theory of the innovation development process. Rogers also writes that more research is needed into the effects of development and other pre-diffusion activities upon the subsequent diffusion of an innovation.

Methodology

The research design for this study involved the use of questionnaires and interviews. Questionnaires and interviews are two of the most commonly-used methods of data gathering in studies related to diffusion research in the field of education (Rogers and Shoemaker, 1971). Instructional developers and potential adopters were asked to report their perceptions of the innovation at the time the training modules were being developed or considered for adoption.

Seven instructional developers who played a significant role in the design and development of the instructional modules were selected and interviewed for this study. The seven developers who were interviewed for the present study performed a variety of tasks during the development of the three modules. An interview guide was used to focus the content of the interviews. One developer interview took place in a face to face setting, the other six interviews were conducted over the telephone.

Potential adopters at each of the six forecasting sites visited by the researcher were selected for the interviews. The forecasting sites represented a geographically diverse sample and included both military and civilian settings. A total of twenty-nine potential adopters were interviewed for this study. An interview guide was used to focus the content of all the interviews. All interviews were conducted in person by the researcher at the forecasting sites.

All potential adopters at each of the six forecasting sites were selected to complete the potential adopters' questionnaire. Questionnaire data were collected from a total of 32 potential adopters of the CBL modules. While thirty-two questionnaires represent a minority of all the forecasters who work at the six sites included in this study, they represent a majority of the forecasters who had used the modules at the time for the study.

Results of the Study

Potential Adopter Questionnaire Data

Questionnaires were distributed at six operational forecasting sites included in this study. Completed questionnaires were received from five of the sites. A total of thirty-two completed questionnaires were received.

Relative Advantage

Table 1
Responses to Statements Related to Relative Advantage

Statement	Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree
The modules are a better way to do on-site training than the way we used to do on-site training.	11 / 34.4%	16 / 50%	4 / 12.5%	1 / 3.1%	0 / 0%
I enjoy on-site training a lot more now than I did before we had the modules.	6 / 18.8%	18 / 56.3%	7 / 21.9%	1 / 3.1%	0 / 0%
I am really looking forward to using future modles.	5 / 15.6%	19 / 59.4%	7 / 21.9%	0 / 0%	1 / 3.1%
I think the modules are effective training tools.	8 / 25%	18 / 56.3%	5 / 15.6%	1 / 3.1%	0 / 0%
The modules are valuable training tools.	6 / 18.8%	21 / 65.7%	5 / 15.6%	0 / 0%	0 / 0%
I think computer-based training is the best way for us to receive on-site training.	5 / 15.6%	13 / 40.6%	9 / 28.1%	4 / 12.5%	1 / 3.1%

Relative advantage is defined as the extent to which an instructional innovation is seen as being superior to, or an improvement over, existing or competing products. The questionnaire contained six items related to relative advantage. The responses to the six questionnaire items referring to relative advantage are reported in Table 1.

As shown in Table 1, responses to the questionnaire items on relative advantage were mostly positive. For example, 84.4% of the forecasters reported that they agreed or strongly agreed the modules "are a better way to do on-site training than the way we used to do on-site training." Also, 75.1% of the forecasters agreed or strongly agreed with the statement "I enjoy on-site training a lot more now than I did before we had the modules."

Complexity

Table 2

Responses to Statements Related to Complexity

Statement	Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree
The modules are user friendly.	7 21.9%	15 46.9%	3 9.4%	6 18.8%	1 3.1%
The directions are adequate for me to figure out what I am supposed to do.	9 28.1%	21 65.7%	2 6.3%	0 0%	0 0%
I had no trouble learning how to use the modules.	11 34.4%	19 59.4%	1 3.1%	1 3.1%	0 0%
I knew when I was supposed to read, watch a video clip, or answer a question.	13 40.6%	16 50.0%	0 0%	3 9.4%	0 0%
Sometimes I felt lost and didn't know how to get to the next screen.	0 0%	6 18.8%	7 21.9%	14 43.8%	5 15.6%
It took me a long time to figure out how to use the	0 0%	1 3.1%	5 15.6%	21 65.7%	5 15.6%
The best thing about the modules is that they are easy to use.	3 9.4%	17 53.1%	11 34.4%	1 3.1%	0 0%

Complexity is defined as the extent to which an instructional innovation is seen as easy to use and user friendly by potential adopters. Seven items related to the perception of complexity were included on the questionnaire. The items refer primarily to the complexity of the user interface of the modules. The responses to the seven questionnaire items referring to complexity are reported in Table 2.

As shown in Table 2, responses to the questionnaire items on complexity were mostly positive. For example, 68.8% of the forecasters reported that they agreed or strongly agreed the modules "are user-friendly." Also, 93.8% of the forecasters agreed or strongly agreed with the statement "I had no trouble learning how to use the modules." The responses of the survey items related to complexity show that the potential adopters in this study perceived the innovation to have a low degree of complexity.

Compatibility

Compatibility is defined as the extent to which an instructional innovation is seen as consistent with the existing values, beliefs, environment, and tools of potential adopters. Six items related to compatibility were included in the questionnaire. The items related to compatibility deal primarily with the how the modules are compatible with the forecasters' work schedule and content knowledge needs. The responses to the six questionnaire items referring to compatibility are reported in Table 3.

Very strong positive responses were given in regard to the work schedule compatibility of the modules. All 32 respondents agreed that breaking the modules into 20 to 30 minute segments was a good way to organize the modules. In another item related to work schedule compatibility, 66% of the respondents agreed that the format of the modules made the modules easy to fit into the forecasters' schedule and workload.

All 29 respondents who expressed an opinion agreed that the best thing about the modules was that they could be used whenever the forecaster wanted. Generally speaking, the responses to the items related to work schedule compatibility were the most strongly positive responses given in regard to any of the perceived attributes.

Table 3
Responses to Statements Related to Compatibility

Statement	Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree
The modules cover topics I need to know about for my job.	7 / 21.9%	18 / 56.3%	3 / 9.4%	3 / 9.4%	1 / 3.1%
Breaking the modules into 20 - 30 minute segments is a good way to organize them.	12 / 37.5%	20 / 62.5%	0 / 0%	0 / 0%	0 / 0%
The modules provide realistic training for my job.	3 / 9.4%	24 / 75%	2 / 6.3%	3 / 9.4%	0 / 0%
The format of the modules makes it easy to fit training into my schedule and workload.	6 / 18.8%	15 / 46.9%	4 / 12.5%	5 / 15.6%	2 / 6.3%
I enjoy working with computers.	9 / 28.1%	14 / 43.8%	6 / 18.8%	3 / 9.4%	0 / 0%
The best thing about the modules is that I can use them whenever I want.	5 / 15.6%	24 / 75%	3 / 9.4%	0 / 0%	0 / 0%

Trialability and Observability

Trialability is defined as the extent to which potential adopters may test or experiment with an instructional innovation prior to adoption. Five items related to trialability were included in the questionnaire. Observability is defined as the extent to which the benefits and outcomes of an instructional innovation can be seen by potential adopters. Seven items related to observability were included in the questionnaire.

Many potential adopters expressed "No Opinion" responses to questionnaire items related to observability and trialability. For example, 84% of the respondents expressed no opinion when asked if they had seen an improvement in their own forecasting as a result of using the modules. Half of the respondents (16 of 32) expressed no opinion when asked if they had noticed that their co-workers seemed to enjoy working with the modules.

The short period of time that the modules had been in use at the work sites is the most likely reason for the high "no opinion" responses in regard to the perception of observability. At the time the forecasters completed the questionnaire, most of the modules had only been in use at the work sites for less than a year. At several sites, in fact, module three had been in use for only a week or two at the time of this study. As for trialability, the forecasters had little say in whether the modules were tried at their worksites. The forecasting organizations selected the sites where the modules would be used. As a result, from the forecasters' view, there was no perceived trialability associated with the modules.

Potential Adopter Interview Data

Twenty-nine weather forecasters from 5 sites were interviewed for the present study. A cross case analysis, grouping the responses of the forecasters in regard to each of the five attributes, is used in this section to summarize the interview data.

Relative Advantage

The relative advantage of the computer-based learning modules was mentioned by all of the twenty-nine potential adopters interviewed for this study. Responses related to relative advantage can be grouped into two categories of advantage. The first category is that the modules are advantageous because they can be used at any time by the forecasters. The second category is that the modules are advantageous because they are more motivational and interesting than other means of training. The first category is a merger of the perceptions of compatibility and relative advantage. Simply stated, many potential adopters felt the modules were advantageous because the modules were compatible with the work schedule of the forecasting office while other forms of training were not. The issue of compatibility will be discussed in greater depth later in this paper.

The second category of relative advantage (Motivational and Interesting) was commonly cited by potential adopters as an important issue. Whenever any of the forecasters discussed the CBL modules in comparison to other methods of on-site training, they always mentioned that the modules were advantageous because they were more motivational and more interesting than the training alternatives. The following statements, taken from the interviews, are representative:

> I enjoy working with the modules. They're more interesting than the manuals. Reading the manuals . . . you talk about dry, that's dry! But this is interactive, more interesting, that's what I like about it.

> I think this is a better alternative than just sitting and reading a manual because this gives you a chance to participate. You have the pictures and animations whereas if you were reading a manual, you would get tired a lot quicker and get bored at a much quicker pace.

> I think they're outstanding. These modules are different, they're interesting, you don't get bored like the other types of training.

> The different types of training we've had, they're boring. These modules, they have a mix - video, animation, text. I like the mix, it makes it much more interesting.

Complexity

When given the opportunity to respond to open-ended questions about the modules, about half of the potential adopters interviewed for this study mentioned complexity as an important issue. Two typical responses are included here:

> Complexity is a big issue, because when you're here on a midnight shift and something goes wrong - if you don't know how to fix it, if you hit a roadblock, then you would tend to shut the thing off and not come back to it for a couple of weeks.

> What I like most about them is you can sit down and start using the

training. You don't have to know how to use computers. They're very easy to use the first time - you don't have to learn how to use the modules.

One of the forecasters interviewed for this study used the open-ended questions to mention complexity as the worst aspect of the modules. This forecaster did not have substantial previous experience using computers. As a result, the forecaster found the modules to be somewhat complicated. A sample of this forecaster's comments are included:

> Well, for me, they're very complicated. I'm not part of the computer generation. I'm just not comfortable with computers. I'm still learning to use them so I have that problem in addition to learning the material.

Compatibility

When given the opportunity to respond to open ended questions about the modules, all of the twenty-nine potential adopters interviewed for this study mentioned compatibility as an important issue. All twenty-nine mentioned that it was important for the modules to be compatible with the work schedule of the forecast office.

The weather is an unpredictable and capricious force. The workload in the forecasting office is largely dependent upon the current weather conditions. When the weather is favorable, forecasters can devote relatively long blocks of time to training. During times of severe weather, it maybe impossiblē for the forecasters to devote any time to training. Several forecasters mentioned that the weather has a major influence on how often they are able to use the modules. Sample comments related to the importance of compatibility to the forecasters are included here:

> The forecaster has the opportunity when the weather is benign. When it's kind of quiet is a good time to work on the modules. He can spend 2 or 3 hours working on them.

> If you have good weather (good weather evening shifts, especially) it's not too bad, you can get back there and use them. We only get scheduled about 4 extra shifts a month and we're lucky if we keep those. So, if you're going to use the modules, the best time is good weather evening shifts.

> That's one of the strong points of the modules, that you can use them in 30 minute chunks of time. Most days you can keep an eye on the weather, take 30 minutes, and do the modules on shift. They're well geared to the type of job we have.

> Fitting them into my schedule is a big thing, the schedule prevents me from using them as much as I'd like. When I get some free time, to be honest with you, I enjoy using them.

Trialability and Observability

When given the opportunity to respond to open ended questions about the modules, none of the twenty-nine potential adopters interviewed for this study mentioned trialability as an important issue. None of the forecasters mentioned the desire or the need to use the modules on a limited basis. When asked specifically about trialability, most of the forecasters reported that they were required to use the modules as part of their work and that they were not given the opportunity to experiment with the modules on a limited basis. There was, in effect, no trialability from the forecasters' standpoint.

When given the opportunity to respond to open ended questions about the modules, none of the twenty-nine potential adopters interviewed for this study mentioned observability as an important issue. When asked specifically about the attribute of observability, none of the forecasters reported that they had seen any observable outcomes resulting from use of the CBL modules.

The reason that most forecasters gave for not observing any outcomes from the module was that the modules had not been in use for very long. The modules had been in use for less than a year at most sites included in this study. Several forecasters reported that they anticipated that the modules would eventually result in observable benefits. The statement included here is representative of most responses related to the attribute of observability:

> I anticipate seeing a change but I haven't seen it yet and that's really because we just haven't gotten into it very much. At this point, it hasn't really gotten into our forecasting but it's just a matter of time.

Instructional Developer Interview Data

Seven developers who contributed to the design and production of the three CBL modules were interviewed for the present study. The purposes of the interviews were to determine the perceptions of instructional developers in regard to the attributes identified by Rogers (1983), to determine if the developers were aware of the perceptions of potential adopters, and to determine how perceptions affected the development of the modules. Data gathered from each of the seven interviews are reported and summarized in the following section.

Organizational Perceptions vs. Individual Perceptions

Instructional developers interviewed for this study tended to discuss the modules in terms of how the modules fit into the overall weather forecasting organization, not in terms of how the modules affected the perceptions of individual forecasters. This is perhaps the most interesting finding of the interviews. In effect, the developers viewed the forecasting agencies, not the individual forecasters, as the potential adopters of the modules.

When asked about any of the perceived attributes identified by Rogers (1983) the developers tended to discuss that attribute from an organizational perspective. For example, when asked to describe the relative advantage of the modules, several developers mentioned that the modules were advantageous because they could be used on-site, allowing forecasters to stay at the worksite instead of traveling to a training center. Having the forecasters train on-site was advantageous to the organization for two reasons, according to the developers. The first is that on-site training relieved staffing and funding issues associated with sending forecasters away for training. The second advantage of on-site training is that it allowed many more forecasters to receive training. Developer #1 made the following comment when asked about the relative advantage of the modules:

> There was a clear advantage in that the National Weather Service runs the training school and they would have 50 or fewer persons per year trained in Kansas City. The need for training is far wider than that . . . there are literally thousands of people who can benefit from the training.

Based upon the seven developer interviews, it is possible to conclude that the developers tended to base the development of the modules more closely on the perceptions of the forecasting organizations than on the perceptions of the individual forecasters. However, the developers' tendency to focus on organizational perceptions is not necessarily improper or worthless. As mentioned above, the adoption situation examined in this study was fairly unique because there were two sets of potential adopters -- the forecasting agencies and the operational forecasters. The developers saw the forecasting agencies as the primary potential adopters of the modules. As a result, the developers concentrated on determining and accounting for the perceptions of the organizations.

Relative Advantage

The instructional developers interviewed for the present study generally discussed the attribute of relative advantage in regard to the organization into which the computer-based training modules would be implemented. Several of the developers mentioned that the modules were advantageous because they provided training at the forecasting site, thereby eliminating the need to send forecasters away for training. Providing training at the forecasting site eliminated many staffing and funding problems associated with sending forecasters away for training. The reduced staffing and funding problems were a major advantage of the modules from the organizations' perspective.

The developers commonly discussed the modules in terms of how they would benefit the organization. When asked how the CBL modules were advantageous to other training products available to the forecasters, Developer #3 discussed how the modules were advantageous to the organization.

> I visited forecast offices, reviewed some of their materials. They've done a variety of things. They've had workshops, which are very expensive and very hard on staffing. I had some knowledge of other products, but really not enough. There were some areas of overlap with other products - we would have been better off looking more into some other products to reduce the overlap.

Three of the seven developers did discuss the attribute of relative advantage in terms of the how the modules were advantageous to the forecasters who would use the modules. Developers #2 and #5 mentioned that they thought forecasters would find the modules more interesting and entertaining than other forms of training. Instructional Developer #2 described his feelings related to the relative advantage of the modules this way:

My feeling was that this had the potential to be a more effective method of training, but equally, I felt it had the potential to be a better received method in the field. I felt people who taking the modules would say "This beats the classroom" or "This beats the videotape."

Developer #3, conversely, mentioned that he felt parts of Module 1 were boring. When discussing the ability of the modules to gain and maintain the users' interest, Developers #2, #3, and #5 were discussing the attribute of relative advantage in terms that closely resembled those used by the forecasters.

Complexity

The complexity of the user interface used in the modules was an important consideration for most of the developers interviewed for this study. Developers #1, #4, and #7 described the process of formative evaluation through which the developers gained information about the interface from the users. Changes were made to the user interface based, in part, upon information gained from the users during the formative evaluation process.

When asked about the complexity of the modules, many developers discussed complexity in terms of the user interface. Developer #4 worked on Module 1 and played a major role in the conceptualization and development of the user interface. Major elements of the user interface developed for Module 1 were incorporated into succeeding modules. The complexity of the user interface was an important consideration for Developer #4 during the development process:

> We did lots of formative evaluation because of the nature of the hypertext system we were developing, the interface became crucially important. We had done what I thought was a very nice interface. We had done some formative evaluation and tested it out with the users.

Developer #1 also mentioned that formative evaluations were an important source of information about the complexity of the modules:

> Based on the evaluations, we changed drastically the presentation of some of the content that was considered too complex or too lengthy. The nature of the changes was to simplify and, in some cases, remove things to try to make the content more understandable

Developer #7 reported that feedback from the potential adopters was used to guide the development of the user interface. During development, the developer perceived that the user interface had a low degree of complexity. Developer #7 had this comment related to the complexity of the user interface:

> The interface is probably one of the best things that we did. We went back to existing workstations and borrowed a lot of the good concepts. We went through a whole series of Formative evaluations with several evaluators coming in. That's how the user interface evolved. It was a very methodical process.

Instructional Developer #3 made an interesting point about how modifications were made to the modules based on input from the formative evaluation groups:

> In the early stages, there are a lot of changes. You get lots of feedback from peers, subject matter experts, and formative review from users. In the later stages, it gets more and more difficult to make changes and the changes you can make have smaller and smaller impact on the overall product. In the early stages, 75 - 90% of the product is changed based on feedback you get from other people.

The statement above points out the need to determine and account for the perceptions of potential adopters early in the development process. In order to effectively account for the perceptions of potential adopters, changes must be made early in the process when changes are easier to make.

Compatibility

Most of the instructional developers interviewed for this study mentioned compatibility as an important issue. All of the developers were aware of the erratic work schedules at the forecasting sites. The developers generally understood that training at the forecasting site had to be designed to allow for short periods of use. Several developers reported that their understanding of the work schedule influenced many development decisions. Developer #4, for example, reported that computer-based instruction was selected as the delivery medium for the training in order to provide maximum flexibility to the forecasters. Developer #7 reported that compatibility was one of the main reasons for selecting the computer-based instructional medium. Several developers also reported that tracking and bookmarking functions were added to the modules in order to allow the forecasters to leave and return to the modules as their schedules dictated, thereby making the modules more compatible with the forecasters' erratic work schedule..

In addition to their background knowledge of the forecasting site, instructional developers formed their perceptions of compatibility through a series of formative evaluations. According to the Developer #1, the evaluations used forecasters from each of the three forecasting agencies. One or two forecasters from each agency were asked to respond to mock-ups and paper representations of the modules. From the formative evaluations, the developing agency gained information related to the compatibility of the modules from the users' viewpoint. Based on input, changes were made to the modules. Instructional Developer #1 described the changes:

> The decision to break up the modules into shorter segments came directly from the tryouts. When they came in for the tryouts, they were put off by the long, detailed, laborious sections and they let it be known that they didn't like that and were quick to say that they didn't believe other people would go through it.

Developer #4 also reported that compatibility was an important consideration for the development team:

> Compatibility was a major reason for going with the computer-based instruction approach. The forecasters were obviously not going to be able to sit down on a consistent basis and use the materials. It was going to be a catch-as-catch-can basis. We built tracking facilities into the design so they could track what parts of the modules they had accomplished. The compatibility to a large extent drove a lot of the development process.

Compatibility was also an important issue for Developer #7. Included here is a representative response made by Developer #7 in regard to compatibility:

> Compatibility was one of the main reasons that CBL was the medium of choice. You couldn't bring all the forecasters in for training. The other option that we've tried many times is to take the experts out to the field offices. You got out to the field office for 2 or 3 days, talk to the forecasters, then you leave. You have to ask yourself 'What kind of impact did that have?' CBL was the answer to that.

From the above statements, we can see that changes were made to the module based upon knowledge that developers gained related to the perceptions of the potential adopters. We see that potential adopters, when shown representations of the module, perceived that the content module was too complex. In the second statement, we see that potential adopters felt the representations were laborious and overly detailed. Based upon that information, the developers shortened the segments and made them less detailed.

Trialability and Observability

Trialability and observability were not mentioned by any of the seven instructional developers interviewed for the present study. None of the developers mentioned that the needs for potential adopters to try the modules on a limited basis or to observe the benefits of the modules were important considerations during the development process.

Developer #6 was one of the few developers interviewed for this study who discussed the attribute of observability in detail. Other developers, when asked directly about observability, either gave short responses or responses that didn't deal closely with observability. The responses of Developer #6 in regard to the attribute of observability serve as an excellent summary and synthesis of the responses of the other developers interviewed for this study. The following response best summarizes the view of all the developers in regard to the role that observability played in the development process:

> [Observability] is probably the most difficult aspect of developing the modules. The performance of the forecasters in the field is so complex that it is very difficult to make any kind of precise, direct correlation between a specific module and a specific reduction in errors. What we wanted is that the effect will be cumulative over time. To say that one module had a specific effect on fore sting would be very, very difficult.

Conclusions and Recommendations

Research Question One

What were the perceptions of instructional developers in regard to relative advantage, complexity, compatibility, trialability, and observability during the development of the computer-based learning modules?

Instructional developers generally did not relate the attributes defined by Rogers (1983) specifically to the forecasters. The relationship between relative advantage, complexity, compatibility, trialability, and observability and the forecasters' opinions of the modules was not commonly discussed by the instructional developers in this study. The instructional developers in this study more commonly discussed the process by which the modules were developed and the implications of the attributes for the organizations in which the modules were used.

When asked directly about the attributes of the modules, instructional developers commonly related the attributes to organizational or systemic issues rather than to the potential adopters of the products. For example, when asked to describe the relative advantage of the modules, most of the forecasters in this study stated that the modules were advantageous because they eliminated the need to take forecasters away from the work site for training.

Research Question Two

What were the perceptions of potential adopters in regard to the relative advantage, complexity, compatibility, trialability, and observability of the computer-based learning modules?

Compatibility, complexity, and relative advantage were important perceptions in the forecaster's decision to adopt or not adopt the computer-based learning modules. Trialability and observability did not emerge as important perceptions to the potential adopters.

Research Question Three

If instructional developers were aware of the perceptions of potential adopters, how did that awareness affect the development of the modules?

The awareness that instructional developers had of the perceptions of potential adopters had a mixed effect on the development of the modules. The developers' awareness of the perception of compatibility had a profound effect on the development of the modules. From the very beginning of the development process, instructional developers knew that compatibility was an important issue to the operational forecasters. They knew this because key members of the development team had experience with the operational forecasting setting. The computer-based learning method was selected because it would allow the forecasters to use the modules at their convenience, when time was available. Also, as a result of their knowledge of compatibility, the developers broke the modules down into shorter digestible segments to make the modules more compatible with the forecasters' work schedules.

During the development process, instructional developers were aware of some of the perceptions of potential adopters and unaware of other perceptions. Developers were aware of the perceptions of potential adopters in regard to complexity and compatibility. Most of the instructional developers were unaware of the perceptions of potential adopters in regard to relative advantage. Trialability and observability were not important perceptions for either group.

Most of the instructional developers interviewed for this study reported that they knew the potential adopters had positive perceptions of the CBL nodules in regard to complexity. Instructional developers in this study knew that the potential adopters perceived the user interface and the content of the modules to have appropriate levels of complexity. Instructional developers also knew that the potential adopters would perceive the modules as being compatible with their needs and work schedule.

Formative evaluations and personal experience were the methods by which the developers became aware of the perceptions of the potential adopters. Instructional developers became aware of the perceptions of potential adopters in regard to complexity through a series of formative evaluation sessions. Instructional developers became aware of the perceptions of potential adopters in regard to compatibility because key members of the development team had personal experience with the operational forecast setting

The developers' awareness of the perception of complexity had a limited effect on the development of the modules. During the development process, instructional developers determined the perceptions of forecasters in regard to complexity through the use of formative evaluations. The knowledge that the developers had about the potential adopters' perception of complexity had a limited effect on the development process, however. Based on the knowledge of complexity from the users' viewpoint, the developers simplified or eliminated some of the content of the modules.

Research Question Four

How did the perceptions of instructional developers and potential adopters compare in regard to the relative advantage, complexity, compatibility, trialability, and observability of the computer-based learning modules?

As stated in Research Question One above, the instructional developers interviewed for this study did not commonly relate their design activities to the perceptions of the end users. The developers discussed their perceptions related to Rogers' attributes only after being asked about them directly by the researcher. Even then, the developers tended to relate the attributes more closely with the perceptions of the forecasting organizations than to the individual forecasters. The forecasters, conversely, readily and consistently used the attributes of compatibility, complexity, and relative advantage to describe their reactions to the modules. It is difficult to compare the perceptions of the two groups because perceptions played a much more prominent role in the potential adopters' discussions of the modules than in the discussions of the instructional developers.

Recommendations

The findings resulting from the analysis of interviews with potential adopters, interviews with instructional developers, and the potential adopter questionnaire lead to the following recommendations.

1. When diffusion is an important consideration, instructional developers should seek to determine the perceptions of potential adopters in regard to the attributes of complexity, compatibility, and relative advantage.

2. When diffusion is an important consideration, instructional developers should consider the perceptions of potential adopters early in the development process.

3. When diffusion is an important consideration, instructional developers should develop products which create a favorable perception of relative advantage for the potential adopters.

4. When diffusion is an important consideration, instructional developers should develop products which create a favorable perception of compatibility for the potential adopters.

5. When diffusion is an important consideration, instructional developers should develop products which create a favorable perception of complexity for the potential adopters.

6. Instructional developers should use formative evaluation as a tool for determining the perceptions of potential adopters in regard to the attributes of complexity, compatibility, relative advantage.

Questions for Future Research

This study examined the role of perceptions in the development and adoption of an instructional innovation. The present study provided insights into six research questions related to perceived attributes. The researcher has identified seven questions arising from the present study which, if studied, could provide valuable additions to the literature related to how perceived attributes affect the development and adoption of instructional innovations.

- *Is there a research methodology for the study of adoption and diffusion that is more efficient and practical than the interview / questionnaire recall methodology?*
- *What are the perceptions of other groups of instructional developers in regard to the relative advantage, compatibility, complexity, trialability, and observability of their products?*
- *How do the perceptions of potential adopters and instructional developers influence the development and adoption of other instructional products?*
- *How do the perceptions of instructional developers and potential adopters compare in situations where the developers and adopters are separated?*
- *Are trialability and observability important perceptions for the potential adopters of other instructional innovations?*

- *Do the attributes of an innovation as identified by Rogers (1983) adequately represent all the attributes of instructional innovations?*

Conclusions

One of the major problems that instructional technologists face is that the products of instructional technology have not found wide acceptance. The underlying assumption of this study is that instructional developers can increase the acceptance of their products by determining and accounting for the perceptions of potential adopters in the development process.

The perceptions identified by E.M. Rogers were important to the potential adopters in this study. All of the potential adopters interviewed in this study used at least one of the attributes identified by Rogers to describe the modules. The language of Rogers was very much a part of the language of the potential adopters. The fact that potential adopters used the attributes identified by Rogers to describe the modules is an important result of this study. This result shows that the perceived attributes of an innovation can be important considerations for those attempting to facilitate the adoption and diffusion of instructional innovations. This conclusion agrees very closely with Wyner's (1974) conclusion that the perceptions of those who use an innovation can provide valuable data to change agents.

Another major conclusion of this study is that instructional developers most often discussed the process by which the modules were developed or the learning strategies used in the modules. Instructional developers very often described the modules in terms of technical or instructional characteristics. When asked directly about the attributes of the modules, developers discussed the attributes in terms of organizational factors, not in terms of how they might affect the individual potential adopter.

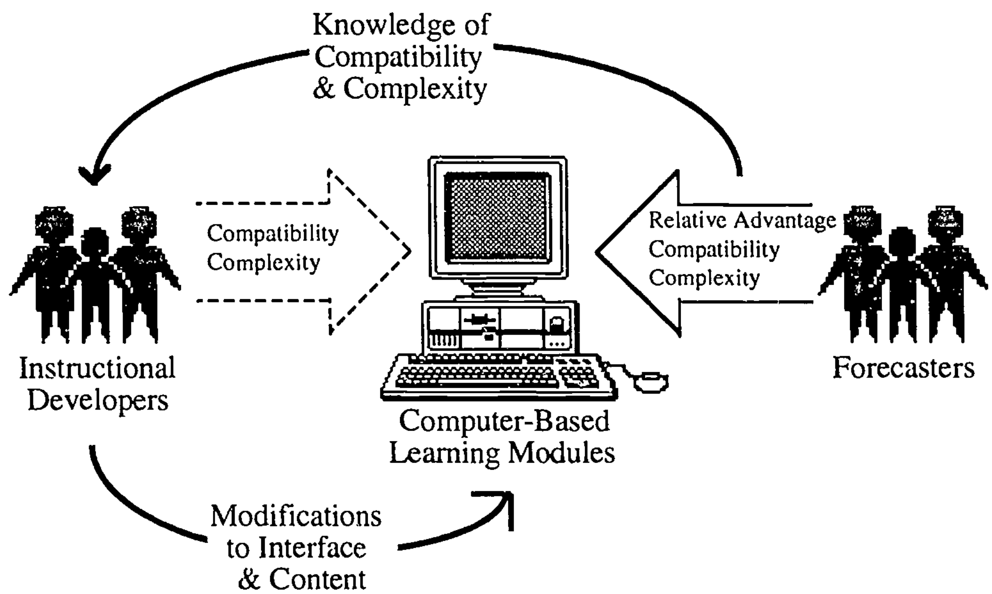

Figure 2. A model showing the findings of the present study.

The theoretical model at the beginning of this paper can be modified to represent the relationship that was found to exist between the instructional developers, perceptions, and potential adopters in the present study. Figure 2 above is a model representing that relationship. As shown in Figure 2, relative advantage, compatibility, and complexity were important perceptions to the potential adopters in this study. Instructional developers had no strongly held perceptions in regard to the attributes defined by Rogers but did consider the compatibility and complexity of the CBL modules during the development process. The developers used formative evaluations and personal experience to gain knowledge of the perceptions of potential adopters in regard to compatibility and complexity. Based in part upon their knowledge of the potential adopters in regard to compatibility and complexity, the developers modified the content and interface of the modules. Trialability and observability were not important perceptions for either group.

In conclusion, the present study sought to determine the relationship between perceived attributes, instructional developers, potential adopters, and the adoption of an instructional innovation. The relationship is a very complex one and requires much additional study. However, the results of this study indicate that the perceived attributes identified by E. M. Rogers do have the potential to offer valuable insights to instructional developers and change agents. The reader is invited and challenged to formulate additional research questions, arising from their own experiences and interpretations of the present study, that might further contribute to the literature related to the importance of perceived attributes in the development and adoption of instructional innovations.

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