Instructional Technology Research Online

Diffusion Theory and Instructional Technology

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Abstract

This paper discusses how the theories of innovation diffusion have been incorporated into the field of instructional technology. The paper begins with a brief description of general diffusion theory that includes mention of the four most commonly discussed diffusion theories. Following the discussion of general diffusion theory, the author describes how general diffusion theories have been used to form diffusion theories specific to the field of instructional technology. The paper states that the two màjor categories of IT-related diffusion theory are Systemic Change Theories and Product Utilization Theories. Examples of each category are provided. The paper identifies and describes two opposing philosophical views of technology: Determinism and Instrumentalism. The author uses the two philosophies of technology to create two subcategories of IT-related diffusion theory: Developer Based Theories and Adopter Based Theories. Examples of both subcategories are provided.The author contends that Developer àBased Theories are flawed in that they overstate the role of technological superiority in the diffusion process.

DIFFUSION THEORY AND INSTRUCTIONAL TECHNOLOGY

The purpose of this paper is to describe how the theory of innovation diffusion has been incorporated

into the field of instructional technology. Professionals in a number of disciplines, from agriculture to marketing, have used the theory of innovation diffusion to increase the adoption of innovative products and practices. Instructional technologists, faced with a growing realization that innovative instructional products and practices have suffered from a lack of utilization, are beginning to turn toà diffusion theory in an effort to increase the adoption of instructional technologies.

Diffusion is defined as the process by which an innovation is adopted and gains acceptance by members of a certain community. A number of factors interact to influence the diffusion of an innovation. The four major factors that influence the diffusion process are the innovation itself, how information about the innovation is communicated, time, and the nature of the social system into which the innovation is being introduced (Rogers, 1995). Diffusion research, in its simplest form, investigates how theàse major factors, and a multitude of other factors, interact to facilitate or impede the adoption of a specific product or practice among members of a particular adopter group.

The study of diffusion theory is potentially valuable to the field of instructional technology for three reasons. First, most instructional technologist do not understand why their products are, or are not, adopted. In a very real sense, the underlying causes of instructional technology's diffusion problem remain a mystery to the field. There appear to be as many reasons for instructional technology's lack of utilization as there are instructional technologists. Some instructional technologists blame àteachers and an intrinsic resistance to change as the primary causes of instructional technology's diffusion problem, others cite entrenched bureaucracies and inadequate funding (Schneberger and Jost, 1994). By better understanding the multitude of factors that influence adoption of innovations, instructional technologist will be better able to explain, predict and account for the factors that impede or facilitate the diffusion of their products.

Second, instructional technology is inherently an innovation-based discipline. Many of the products produced by instructional technologists represent radical innovations in the form, organization, sequence, and delivery of instruction. An instructional technologist who understands the innovation process and theories of innovation diffusion will be more fully prepared to work effectively with clients and potential adopters (Schiffman, 1991).

Third, the study of diffusion theory could lead to the development of a systematic, prescriptive model of adoption and diffusion. Instructional technologists have long used systematic models to guide the process of instructional development (ID). These systematic ID models have resulted in the design and development of effective and pedagogically sound innovations. A systematic model of diffusion could help guide the process of adoption and diffusion in a similar manner and, perhaps, with similarly effàective results.

General Diffusion Theory

Before discussing how diffusion theory has been incorporated into instructional technology, I will provide a brief background and overview of general diffusion theory. The most important fact to consider

in discussing diffusion theory is that it is not one, well-defined, unified, and comprehensive theory. A large number of theories, from a wide variety of disciplines, each focusing on a different element of the innovation process, combine to create a meta-theory of diffusion.

The most likely reason why there is not a unified theory of diffusion is that the study of innovation diffusion is a fairly recent field. Rogers (1995) points out that a 1943 study by Ryan and Gross at Iowa State University provided the genesis of modern diffusion research. The Ryan and Gross (1943) study, from the field of rural sociology, used interviews with adopters of an innovation to examine a number of factors related to adoption. The interview-based methodology used in the Ryan and Gross study àhas remained the predominant diffusion research methodology ever since (Rogers, 1995). A number of researchers from rural sociology (e.g., Fliegel and Kivlin, 1962) and other disciplines (e.g., Weinstein, 1986) have built on the Ryan and Gross' work to conduct studies and develop theories related to the diffusion of innovations.

The researcher who has done the most to synthesize all of the most significant findings and compelling theories related to diffusion is Everett M. Rogers. Rogers' book Diffusion of Innovations, first published in 1960, and now in its fourth edition (Rogers, 1995) is the closest any researcher has come to presenting a unified theory of diffusion.. Four of the theories discussed by Rogers are among the most widely-used theories of diffusion: Innovation Decision Process; Individual Innovativeness; Rate ofà Adoption; and Perceived Attributes.

Innovation Decision Process

The Innovation Decision Process theory (Rogers, 1995) states that diffusion is a process that occurs over time and can be seen as having five distinct stages. The stages in the process are Knowledge, Persuasion, Decision, Implementation, and Confirmation. According to this theory, potential adopters of an innovation must learn about the innovation, be persuaded as to the merits of the innovation, decide to adopt, implement the innovation, and confirm (reaffirm or reject) the decision to adopt the innovaàion. This theory has been so widely cited in the instructional technology literature that Sachs (1993) writes, somewhat derisively, "after looking at [the literature] in our field, one might get the impression that the only important thing we need to know about how to encourage the adoption of innovations or how to be better change agents is that there are five stages to the innovation adoption process (p. 1)". While Sachs correctly concludes that many other important theories of innovation diffusion areà overlooked, the Innovation Decision Process theory remains among the most useful and well known.

Individual Innovativeness

The Individual Innovativeness theory (Rogers, 1995) states individuals who are predisposed to being innovative will adopt an innovation earlier than those who are less predisposed. Figure 1 shows the bell shaped distribution of Individual Innovativeness and the percentage of potential adapters theorized to fall into each category. On one extreme of the distribution are the Innovators. Innovators are the risk takers and pioneers who adopt an innovation very early in the diffusion process. On the other eàxtreme are the

Laggards who resist adopting an innovation until rather late in the diffusion process, if ever.

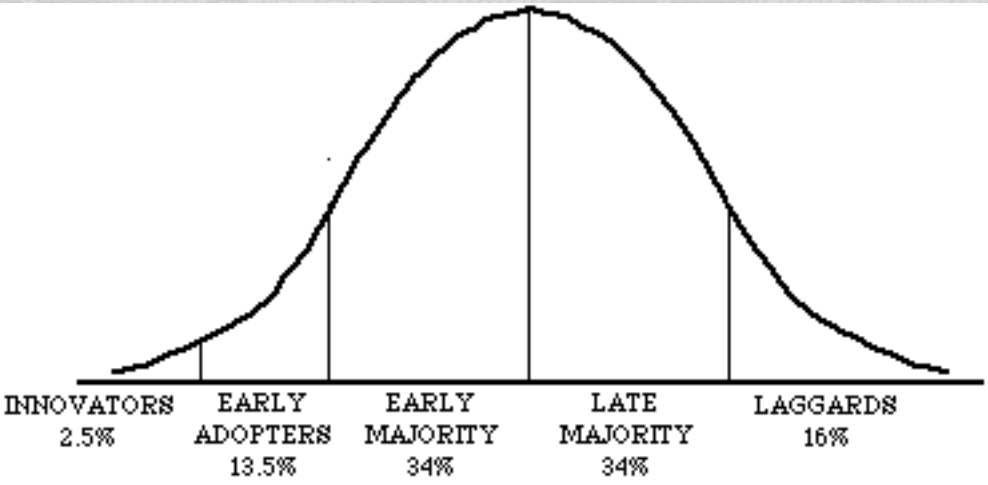

Figure 1. Bell shaped curve showing categories of individual innovativeness and percentages within each category

Rate of Adoption

The third widely-used diffusion theory discussed by Rogers (1995) is the theory of Rate of Adoption. Rate of Adoption theory states that innovations are diffused over time in a pattern that resembles an s-shaped curve. Rate of Adoption theorizes that an innovation goes through a period of slow, gradual growth before experiencing a period of relatively dramatic and rapid growth. An example of how rate of adoption might typically be represented by an s-curve is shown in Figure 2. The theory also states tàhat following the period of rapid growth, the innovation's rate of adoption will gradually stabilize and eventually decline.

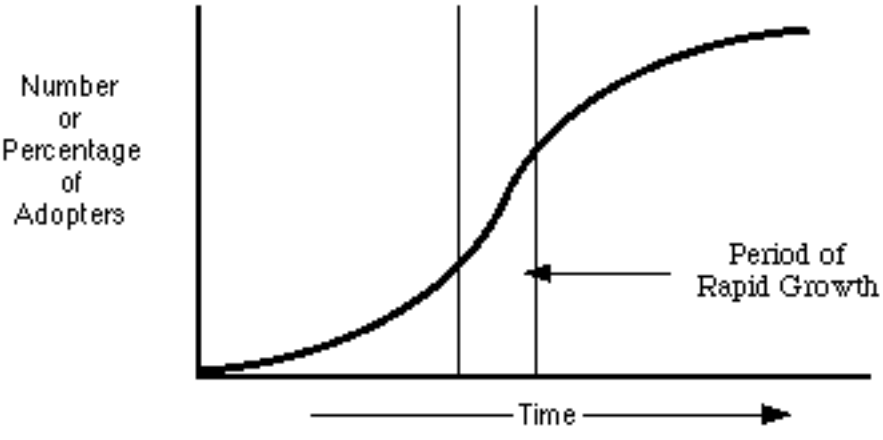

Figure 2. S-curve representing rate of adoption of an innovation over time

Perceived Attributes

The Theory of Perceived Attributes (Rogers, 1995) states that potential adopters judge an innovation

based on their perceptions in regard to five attributes of the innovation. These attributes are:Trialability; Observability; Relative Advantage; Complexity; and Compatibility. The theory holds that an innovation will experience an increased rate of diffusion if potential adopters perceive that the innovation: 1) Can be tried on a limited basis before adoption; 2) Offers observable results; 3) Has an adàvantage relative to other innovations (or the status quo); 4) is not overly complex; and 5) Is compatible with existing practices and values.

The Theory of Perceived Attributes has been used as the theoretical basis for several studies relevant to the field of instructional technology. Perceptions of compatibility, complexity, and relative advantage have been found to play a significant role in several IT-related adoption studies. Wyner (1974) and Holloway (1977) each found relative advantage and compatibility to be significant perceptions among potential adopters of instructional technology in high schools. Eads (1984) found compatibility àwas the most important attribute among students and school administrators. Surry (1993) studied the perceptions of weather forecasters in regard to innovative computer based training and found relative advantage, complexity and compatibility were important adoption considerations.

Instructional Technology Diffusion Theory

A number of researchers have attempted to use the general theories of innovation diffusion to develop diffusion theories specific to the field of instructional technology. It would be impossible for one paper to adequately discuss in detail the techniques and purposes of all of these attempts at theory building. Even providing a brief synopsis of each major application of diffusion theory to IT would result in a lengthy discussion far beyond the scope of any one paper. I will limit the present paper to àa discussion of the broad goals and major philosophical premises of instructional technology diffusion theory.

Macro and Micro Theories

Applications of diffusion theory to instructional technology can be grouped into two major, categories with distinctly separate goals. The first major category focuses on the reform and restructuring of educational institutions. The goal of this category of IT diffusion research is to develop theories of organizational change, most commonly school change, in which technology plays a major role. Examples of this category include Reigeluth's (1987) Third Wave Educational System, The Schoolyear 2000 modàel (Center for Educational Technology, 1989), and the New American Schools Development Corporation (NASDC) (Mehlinger, 1995). These theories, often referred to as systemic change theories, typically involve the adoption a wide range of innovative technologies and and practices. Because of their broad scope, systemic change theories can be thought of as macro-level IT diffusion theories.

The second major category of IT diffusion research focuses on increasing the adoption and utilization of specific instructional products. The goal of this category of research is to develop theories of technology adoption that will lead to a more widespread use of instructional innovations. Examples of product adoption and utilization theories include Burkman's (1987) User-Oriented Instructional Development process, Environmental Analysis (Tessmer, 1990), Adoption Analysis (Farquhar and Surry, 1994), àand

the Technological Imperative Model (Schneberger and Jost, 1994). Theories in this category are not concerned with large scale, systemic change, but focus on the adoption of a specific innovation by a specific set of potential adopters. Because of their focus on specific innovations and specifics environments, these theories are, in effect, micro-level IT diffusion theories.

The two major categories of IT-related diffusion research, which I will call Macro, or Systemic Change Theories, and Micro, or Product Utilization Theories, can each be divided into two subcategories. These subcategories represent the two predominant philosophies of technology and technological change: Technological Determinism and Technological Instrumentalism. Before discussing the subcategories, which I will call "Developer (Determinist)" and "Adopter (Instrumentalist)", I will provide a brief overàview of the two predominant philosophies.

Determinist versus Instrumentalist

From a theoretical standpoint, views of technology range on a continuum from technological determinism to technological instrumentalism. Autonomy and continuity are the key issues in the philosophical debate between determinists and instrumentalists. Technological determinists view technology as an autonomous force, beyond direct human control, and see technology as the prime cause of social change (Chandler, 1995). Determinists view the expansion of technology as discontinuous. They see technologicalà growth not as a gradual, evolutionary process, but as a series of revolutionary leaps forward (McCormack, 1994).

Among the most widely-cited deterministic works is Toffler's (1971) book Future Shock. Toffler concisely outlines the determinist's philosophy when, after citing several examples of accelerated economic growth, he writes "behind such prodigious economic facts lies that great, growling engine of change - technology" (p. 25). While acknowledging that technology is not the only force in social change, Toffler adds, "technology is indisputably a major force behind this accelerative thrust" (p. 25) and "by noàw the accelerative thrust triggered by man has become the key to the entire evolutionary process of the planet" (p.485).

Technological determinists, united in their belief that technology is an autonomous and revolutionary force, often differ in their opinion of the morality of technology. Determinists commonly have either a radically utopian or radically dystopian opinion on technology (Kaplan, 1996). Figure 3 provides an outline of the respective positions. Utopian determinists believe that technology is a positive and uplifting force that will, over time, mitigate or eliminate most or all of the ills that afflict humaànity. They believe technology is leading society towards an ever more utopian existence. Karl Marx is the most often cited example of a utopian determinist philosopher, although the exact nature of his philosophy is a hotly debated question (Misa, 1994). Other well known utopian determinists include Marshall McLuhan and Alvin Toffler.

Dystopian determinists believe that technology is an inherently evil, or dehumanizing, force that will lead, inevitably, to the moral. intellectual, or physical destruction of humankind. Jacques Ellul's (1964)

work *The Technological Society* is the seminal writing in technological determinism and provides a classic outline of the dystopian position. Another well-known dystopian determinist is George Orwell (1949) who provides a fictional account of the dehumanizing effects of technology in his càlassic novel *1984.*

Philosophy of Technology	Philosophical Premise	Notable Advocates	Examples from IT
Utopian Determinism	Technology is an inevitable, autonomous force that will lead to prosperity and be the salvation of humanity	Karl Marx Marshall McLuhan Alvin Toffler Technology Zealots	RDD Paradigm ID Models Systemic Change
Dystopian Determinism	Technology is an inevitable, autonomous force that is morally corrupt and will lead to the destruction of humanity	Jacques Ellul George Orwell Unabomber Luddite Movement	Change Resistors
Instrumentalism	Technology is under human control and its use can lead to beneficial or disastrous consequences	Daniel Chandler Paul Levinson Donald MacKenzie	Ernest Burkman

Figure 3. The three prevailing views of technology and their relationships to instructional technology.

Opposed to the determinist philosophers are the instrumentalist philosophers. Human control over technology is the issue that most dramatically divides instrumental philosophers and determinist philosophers. Technological instrumentalists, as their name may imply, view technology as a tool. The instrumentalists often cite the knife as an example of their philosophy (Levinson, 1996). A knife is a tool and can be used for either good or evil, depending upon the intentions of the person employing the toolà Extrapolating from that simple example, instrumentalists believe that all technology is a tool, largely under human control, that can be used for either positive or negative purposes. While determinists see technology as the most powerful force for change, instrumentalists see social conditions and human aspiration as the primary causes of change. The other major difference between the two philosophies is that instrumentalists view the growth of technology as an evolutionary process, not as a series of àrevolutions or technological leaps (Levinson, 1996). They see technological growth as the ultimate culmination of a long history of slow, gradual expansion.

As mentioned above, the two major categories of IT-related diffusion research can be sub-divided into two subcategories. The result is a breakdown of IT-related diffusion theory into four areas. The areas are shown in Figure 4. I will now describe the two subcategories, Developer Based and Adopter Based, in more detail

PHILOSOPHY	GOAL: Systemic Change (Macro)	GOAL: Product Utilization (Micro)
Developer (Determinist)	Focus on the structure and establishment of an effective organizational framework.	Focus on process of designing, developing, and evaluating effective instructional products
Adopter (Instrumentalist)	Focus on the social, political, and professional environment in specific organizations	Focus on the needs and opinions of potential adopters and characteristics of the adoption site.

Figure 4. Overview of Instructional Technology Diffusion Theories showing diffusion goal and philosophical view.

Developer Based (Determinist) Theory

The goal of developer based theory is to increase diffusion by maximizing the efficiency, effectiveness and elegance of an innovation. The developer, or architect, of superior technology is seen as the primary force for change. The underlying assumption of developer based theories is deterministic in its belief that superior technological products and systems will, by virtue of their superiority alone, replace inferior products and systems. Developer based theories of diffusion see change as following dàirectly from a technological revolution.

Developer based theories in instructional technology assume that the best way to bring about educational change is to create a system or product that is significantly superior to exiting products or systems. Potential adopters are viewed as being predisposed to adopt innovations that are quantifiably superior. Top down school reform efforts such as the Goals 2000 initiative (Mehlinger, 1995) are excellent examples of developer based diffusion theories. These top down reform efforts seek to diffuse eduàcational change by proposing educational systems that are superior to existing systems. By specifying goals, organizational structures, managerial philosophies, instructional products, and fiscal strategies that have been proven to be, or at are least theorized to be, superior to existing practice, top down school reformers are counting on technological superiority to bring about change.

Instructional development (ID) models are another example of developer based theories of diffusion. Diffusion is not an element overtly described in a typical ID model (Andrews and Goodson, 1991), but the adoption of an innovation does have an implied place in the ID process. Diffusion through technological superiority is the implicit goal of the process. Andrews and Goodson (1991) list four purposes of systematic instructional design: Improved learning; improved management (of the ID process), improveàd evaluation (of products); and theory building. Three of the four purposes center on the creation of technologically superior products. The instructional development process assumes that technological superiority is a sufficient condition that will lead directly to the adoption and diffusion of

innovative products and practices.

Limitations of Developer Based (Deterministic) Theories

Instructional development is a process based on the research, development, and diffusion (RDD) paradigm (Burkman, 1987). Saettler, in the first edition of is classic work *A History of Instructional Technology* (1968) provides an insight into the thinking of those who were early advocates of the RDD approach when he writes:

"In the education sector, it is becoming increasingly apparent to scientifically oriented educators that education must discard the folklore approach to instruction and move forward to new frontiers, this includes the development of instructional systems based on behavioral science theory, research, and development." (p. 270).

As Saettler describes, one of the hallmarks of the RDD approach is to abandon "folklore" approaches to education and, in their place, to develop systematic, scientific alternatives. Saettler writes that the systems engineering approach has been the foundation of industrial engineering since the beginning of the industrial revolution and that "one of the most successful applications of the systems concept . . . was the development of the atomic bomb" (p. 269).

While there can be ethical debate as to whether the same process used to develop the atomic bomb should be used to develop human minds, there can be little argument that the continuing refinement and wider use of the RDD paradigm have resulted in the creation of instructional products that are pedagogically sound and technically advanced. Instructional technologies greatest challenge is not developing effective products, but developing effective products that people want to use. As Dalton (1989) writesà, "although w can fill instructional gaps with fervor, we never seem to examine our solutions in light of the wants of the implementors" (p. 22). Hall and Hord (1987) point to the failure of many large-scale curriculum reform projects in the 1960s as evidence that instructional technology has failed to meet the challenge of utilization.

The primary limitation of instructional development theory, and the RDD paradigm upon which it is based, is their inherent deterministic bias. There is a general consensus in the diffusion and adoption literature that technological superiority alone is not enough to guarantee the adoption of an innovation. In fact, some would argue whether technological superiority is even a necessary condition, at least at the beginning of the adoption process (MacKenzie, 1996). If technological superiority is not suffàicient to increase adoption, where does that leave us? Several instructional technologists suggest that the ultimate answer to this important question can be found in a more instrumentalist approach to diffusion.

Adopter Based (Instrumentalist) Theory

Adopter based theories focus on the human and interpersonal aspects of innovation diffusion. Adopter based theories are inherently instrumental in philosophy because they view the end user -- the individual who will ultimately implement the innovation in a practical setting, as the primary force for change.

These theories reject the assumption that superior products and practices will automatically be attractive to potential adopters.

Segal (1994) states the importance of adopter based theories when he writes "all structures and machines, primitive or sophisticated, exist in a social context and, unless designed for the sake of design itself, serve a social function" (p.2). Adopter based theories seek to understand the social context in which the innovation will be used. Tenner (1996) describes the concept of revenge effects which is central to many adopter based theories. Revenge effects occur when "new structures, devices, and orgaànisms react with real people in real situations in ways we could not foresee" (p.9). Predicting and account for probable revenge effects caused by an innovation is a defining component of many adopter based diffusion theories.

Adopter based theorists (e.g., Tessmer, 1990) argue that a variety of factors, most unrelated to technical superiority, influence the decision to adopt or reject an innovation. Adopter based theorists such as Burkman (1987) often site the QWERTY and Dvorak keyboard example. The Dvorak keyboard configuration is superior and allows for more efficient and faster typing. However, since most typists learned to type using the QWERTY configuration and are comfortable with that configuration, there is great ràeluctance to adopt the Dvorak configuration, despite its superiority. This is a classic example of how human, interpersonal, and social factors often play a more significant role in adoption than technological superiority.

Examples of adopter based theories can be found in both the Macro and Micro categories of IT diffusion research. Ernest Burkman (1987) was the first major author in the field to suggest a Micro (Product Utilization) theory based on an instrumentalist view of instructional technology. Burkman's theory of a user-oriented instructional development (UOID) rejects the idea that technological superiority is a sufficient condition for the adoption of an instructional product. In UOID, the opinions, needs, andà perceptions of the potential adopters are seen as the primary forces that influence adoption.

Burkman's User Oriented Instructional Development process consists of 5 steps:

1. Identify the potential adopter
2. Measure relevant potential adopter perceptions
3. Design and develop a user-friendly product
4. Inform the potential adopter (of the product's user-friendliness)
5. Provide Post Adoption Support

Burkman's UOID is representative of instrumentalist philosophy because UOID assumes the end user is the most important force in the adoption of a new product. Other adopter-based theories of product utilization include Stockdill and Morehouse's (1992) adoption checklist and Farquhar and Surry's (1994) Adoption Analysis.

Hall and Hord's (1987) Concerns Based Adoption Model (CBAM) is a notable example of a Macro (Systemic Change) theory of diffusion that is instrumentalist, rather than determinist, in philosophy. Hall

and Hord describe a process in which change facilitators understand change from the point of view of the people who will be affected by change. The idea of CBAM is to bring about systemic restructuring by understanding the social, political, and interpersonal aspects of the school. The Coalition of essentiaàl Schools, and many other Bottom Up reform strategies (Mehlinger, 1995), are other examples of adopter based, systemic change theories.

In this section, we have seen that diffusion theory has been incorporated in the field of instructional technology in a number of ways, both subtle and overt. We have seen that diffusion theories can have as their goal the total restructuring of an entire instructional system or the adoption of a specific instructional product. We have also seen that theories of adoption and diffusion can represent either a determinist or instrumental philosophy. Figure 5 shows examples of instructional technology diffusàion theories in each of the four resulting areas.

PHILOSOPHY	GOAL: Systemic Change (Macro)	GOAL: Product Utilization (Micro)
Developer (Determinist)	Top Down Reform NASDC Goals 2000	ID Models Needs Assessment Formative Evaluation Summative Evaluation
Adopter (Instrumentalist)	Bottom Up Reform CBAM Coalition of Essential Schools	Burkman's UOID Environment Analysis Adoption Analysis Stockdill & Morehouse

Figure 5. Major theories representative of each of the four areas of instructional technology diffusion research

Conclusions

The field of instructional technology is a broad and diverse field. Instructional technologists routinely incorporate theories from communication, cognitive psychology, management, computer science, behavioral psychology and many other fields into the development of instructional products and systems. In this paper, I have discussed several important ways that instructional technologists have begun to incorporate the theories of innovation diffusion. The increased awareness of diffusion's importance anàd expanded use of diffusion theories are of potentially great benefit to instructional technology

In order to maximize the potential benefit of diffusion theory, instructional technologists should adopt a more instrumentalist philosophy of technology. No reasonable diffusion theorist would suggest that technological superiority is the only necessary condition for diffusion. Instructional technologists have been seduced by the simplicity and basic logic of technological determinism. The decision to adopt an innovation, however, defies simple logic. The best products are not always the ones people wàant to use.

As MacKenzie (1996) writes: "Technologies . . . may be best because they have triumphed, rather than triumphing because they are best" (p. 7).

Superior technology does not always steam roll inferior technology, as the determinists believe. Nor does a superior technology explode onto the scene in a glorious, perfect form -- it creeps along in fits and starts. Technology's advance may be inevitable, but it is gradual. Instructional technologists should, therefore, look to the potential adopters to show us ways to gradually introduce our innovations into their societies.

Of course, while a less determinist philosophy would be beneficial to instructional technology, a totally instrumentalist philosophy would be disastrous. Turning out technically inferior and pedagogically weak products that people want to use is not the answer. Every technologist is inherently a determinist. There is no danger in being driven to improve society by improving instructional technology. The danger is to ignore the society we are attempting to improve.

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