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# Accelerating the Diffusion of Innovations Using Opinion Leaders

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ABSTRACT: Theory on the diffusion of innovations has been used to study the spread of new ideas and practices for over 50 years in a wide variety of settings. Most studies have been retrospective, and most have neglected to collect information on interpersonal communication networks. In addition, few have attempted to use the lessons from diffusion research to accelerate the diffusion of innovations. This article outlines a method to accelerate the diffusion of innovations using opinion leaders. The authors present their optimal matching procedure and report on computer simulations that show how much faster diffusion occurs when initiated by opinion leaders. Limitations and extensions of the model are discussed.

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MANY programs, interventions, and communication campaigns are designed to change an organization or community by directing messages at mass or local audiences. These messages are disseminated to the entire audience with little regard for the internal structure of that organization or community. The structure of communities and organizations can be thought of as a network of interconnected individuals—a network that can be used, rather than ignored, when creating programs. This article details the theoretical and methodological principles underlying one network approach for promoting social change within organizations and communities.

Many programs have been evaluated that use mass media and/or interpersonal communication for behavior change (Valente and Saba 1998). These programs have been conducted to address topics such as cardiovascular disease risk reduction (Flora, Maccoby, and Farquar 1989), family planning (Piotrow et al. 1997), HIV/AIDS prevention (Janz et al. 1996), oral rehydration therapy (Snyder 1990), and stress reduction (Hamburg and Varenhorst 1972). In many settings, only interpersonal communication is used to promote behavior change via diffusion through peer networks or outreach activities in an attempt to capitalize on interpersonal influence to promote and catalyze desired behavioral changes (Jemmott, Jemmott, and Fong 1998; Neaigus 1998).

The impact of these interventions is varied. The relative and absolute efficacy of peer networks and mass media interventions is not uniform. Part of this inconsistency stems from differences in definitions of what constitutes peer networks, the behaviors being promoted, or the settings and structure of the implementation of the programs. This article addresses the definitional problem by outlining the various approaches that are referred to as peer education models. We then present a methodology that can be used to enhance existing peer education models that capitalizes on learning theory and the diffusion of innovations. Next, we present a computer simulation to illustrate the method and report results intended to show its predicted efficacy. Finally, we discuss possible limitations and extensions to the model.

## DIFFUSION OF INNOVATIONS VIA SOCIAL NETWORKS

Diffusion of innovations theory explains how new ideas and practices spread within and between communities. This theory has its roots in anthropology and sociology (see Tarde 1903) with some principles adapted from epidemiology (Bailey [1957] 1975 or even Bernoulli 1760). The basic premise, confirmed by empirical research, is that new ideas and practices spread through interpersonal contacts largely consisting of interpersonal communication (Beal and Bohlen 1955; Hägerstrand 1967; Katz, Levine, and Hamilton 1963; Ryan and Gross 1943; Rogers 1995; Valente and Rogers 1995; Valente 1995).

Ryan and Gross laid the groundwork for the diffusion paradigm in a 1943 publication that found that

social contacts, social interaction, and interpersonal communication were important influences on the adoption of new behaviors (Valente and Rogers 1995). Their groundbreaking study was followed by several hundred diffusion studies conducted in the 1950s and early 1960s to examine the diffusion process in more detail across a wide variety of topics (Rogers 1995). Most studies supported the idea that interpersonal contacts were important influences on adoption behavior. Researchers sought to understand how information created in government or other organization-sponsored programs had been disseminated within an interpersonal communication environment. Although many factors influence innovation diffusion, scholars have consistently found that interpersonal contacts within and between communities are very important influences on adoption behavior (Valente 1995).

Although many scholars agree on the importance of interpersonal communication to the diffusion process, few studies have successfully traced an innovation through a network of social contacts. The lack of data on diffusion within an entire network stems largely from the difficulty of collecting data over a time period long enough for diffusion to occur. As a consequence, most studies have relied on retrospective data, which might introduce some bias (Coughenour 1965; Nischan et al. 1993).[1] A more serious limitation of retrospective data is that they may capture a post hoc explanation for diffusion, which masks the actual processes responsible for the spread of the innovation.

Given the importance of interpersonal contacts in diffusion, scholars have sometimes relied on formal methods of measuring who talks to whom within a community. Such methods are known as network analysis (Scott 1991; Wasserman and Faust 1994; Rogers and Kincaid 1981). Network analysis is a set of methods that enables researchers to locate individuals who are more central to a community and thus perhaps more influential. The basic diffusion network model uses these individuals, or opinion leaders, to initiate the diffusion of a new idea or practice. They can function as champions for the new practice and accelerate the diffusion process (Valente 1996; Katz 1957; Katz and Lazarsfeld 1955). The opinion leader often functions as the theoretical underpinning to peer education programs.

## OPINION LEADER MODELS OF DIFFUSION

Interventions designed to use interpersonal communication for promoting behavior change are often referred to as peer influence, peer education, interpersonal counseling, outreach, or peer networks. Implicit in the peer promotion model is the assumption that some individuals will act as role models for others. These role models act as opinion leaders within their communities and can be important determinants of rapid and sustained behavior change. Research findings support

this principle. In one study, opinion leaders were shown to be effective at decreasing the rate of unsafe sexual practices (Kelly et al. 1991). In another study, opinion leaders were effective at decreasing the rate of cesarean births (Lomas et al. 1991). These findings imply that maximizing the effectiveness of these opinion leaders can further accelerate the rate of diffusion.

An important corollary to the recognition of the function of opinion leaders is to determine how they are selected. Several potential recruitment procedures exist:

1. Individuals select themselves to be peer leaders.
2. Program staff or project teams select the leaders.
3. Community members recruit participants, not leaders, who in turn each recruit new participants (Broadhead et al. 1995).
4. Some selected individuals within the community nominate others to be opinion leaders (Kelly et al. 1991).
5. All community members are invited to nominate opinion leaders (Lomas et al. 1991; Wiist and Snider 1991).

There are several limitations to the effectiveness of each of these approaches. The degree of influence wielded by an opinion leader is predicated in part on the potential adopters' assessment of his or her credibility and trustworthiness. Self-selected leaders and those selected from outside the community (methods 1 and 2) could each be suspected of having agendas different from those of the members of the community or even agendas harmful to community members. Equally damaging to the potential for influence is the perception that the leader is unaware of the community's needs or that the leader may not be sufficiently knowledgeable about the innovation. Finally, persons not selected by community members may use persuasion tactics that are not effective in that community.

The third technique, the snowball approach, avoids the selection bias problem by allowing all community members to participate in the intervention (regardless of their leadership status) by being both a recruiter and a "recruitee." This snowball approach may be used to recruit individuals to receive a service (such as a clinical screening) or to disseminate information. One problem with the snowball approach is that complex ideas and behavior change recommendations may not be effectively communicated by everyone, and hence the strategy may be limited to easily communicated messages (a chain is only as strong as its weakest link). An additional limitation is that there is no opportunity to capitalize on the networks since the dynamic nature of the snowball is temporary.

Allowing community members to nominate leaders, as in the fourth technique, overcomes these disadvantages by providing a pool of recognized community leaders. Using only a select few individuals to nominate leaders may, however, decrease the validity or reliability of the process. Moreover, the desired outcome (that

the leaders be effective) may be highly dependent on the persons chosen to do the selecting.

Allowing all community members to nominate leaders (the fifth technique) overcomes most of the shortcomings of the other techniques. The list of opinion leader nominations that it produces provides an accurate map of who goes to whom for advice within the entire community. The strategy exploits the existing structure of information dissemination within the community and relieves the need to impose an artificial information flow network from above. This technique has been successfully employed in several arenas. For example, rotating credit-associations in developing countries take a census of all community members and permit them to nominate program leaders. The nomination technique follows the principle underlying democratic forms of government.

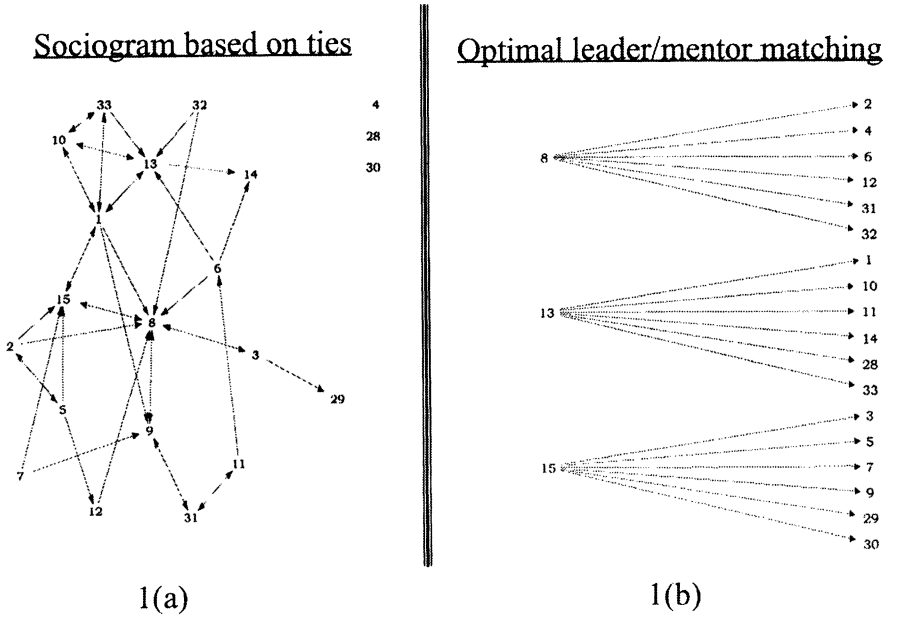
A community or organization attempting to initiate behavioral change ensures the credibility and trustworthiness of opinion leaders by allowing the entire community to select opinion leaders. A second advantage of this approach is that the number of leaders selected for training can be varied depending on the needs of the intervention. Third, the boundaries used to define leaders can be varied to account for group membership properties (for example, opinion leaders can be recruited based on gender, ethnicity, geography, or the like).

The nomination method identifies the leaders to be trained in the intervention. The leaders can then be instructed to disseminate information to the general community or used in a one-to-many matching so that leaders train or teach those community members that specifically nominated that particular opinion leader. The one-to-many strategy provides an optimal match of community members to recognized community leaders in a form suitable for accelerating diffusion of information, innovation, and community change.

The approach taken in this article is to develop a model designed to identify opinion leaders as designated by sociometric techniques (Rogers and Cartano 1962). Leaders can be chosen as those who received the most nominations, or, alternatively, more complicated centrality algorithms can be used (Borgatti, Everett, and Freeman 1998; Freeman 1979; Valente and Foreman 1998). These leaders are then matched with those who nominated them to create an optimal interpersonal pairing. The leaders can then be given educational materials to educate or train those with whom they have been paired. This diffusion network perspective thus capitalizes on the principles of learning theory (Bandura 1986) and diffusion (Rogers 1995; Valente 1993; Valente and Rogers 1995), which dictate that learning occurs most efficiently when individuals are trained by their "near peers" whom they have chosen as their models (Rice 1993).

Once leaders are identified, they can be matched to the persons in the community who nominated them. If someone did not directly nominate a

FIGURE 1
**NETWORK OF PHYSICIANS IN AN ILLINOIS COMMUNITY**




SOURCE: Coleman, Katz, and Menzel 1966.

leader, that person is matched to a leader who is closest to him or her. If an individual is equally close to two or more leaders, then indirect paths connecting this person to these leaders can be used to determine the optimal pairing. For example, if person X nominates both leaders A and B, but has more or shorter indirect paths to A rather than B, then X can be matched to A. Computer algorithms that optimally match community members to leaders can then be constructed using direct and indirect paths between members and leaders.

For example, Figure 1(a) displays the sociogram of network nominations for the study by Coleman, Katz, and Menzel (1966) of the diffusion of tetracycline prescriptions among physicians in one Illinois community in the mid-1950s. This graph shows the network of connections between 21 physicians in the community and is a picture of who goes to whom for advice about medical matters.[2] In Figure 1(b), the sociogram has been redrawn so that central nodes (physicians) are matched to the nodes that nominated them or are closest sociometrically. This provides an optimal matching of opinion leaders to the community members who look to each of them for advice and thus can be used to accelerate the diffusion process.

As shown in Figure 1(a), members 8, 13, and 15 are central to the

network, receiving the most nominations. After the network has been reconfigured, the exact leader-to-learner matchings have been carried out. The matching provides a strategy that can be used to implement behavioral promotion programs. Everyone in the community is matched to a leader, some from their direct links and others via their indirect links.

Partitioning a network into these leader-follower pairings is relatively straightforward. In many settings, networks will partition into leader-follower pairs unambiguously, while in others the partitioning may be more ambiguous for a number of reasons. One impediment to optimal matching is if the network has one or a small group of people who receive a preponderance of the nominations. In network terms, such a network is highly centralized. In a centralized network, most (or all) members would be assigned to one (or a few) leader(s). Matching in highly centralized networks will have too many individuals assigned to the same leader. The solution to this problem will be to have some of the persons assigned to leaders nominated indirectly. The percentage of these nonoptimal pairings would provide a measure of the fidelity of the opinion leader model implementation.

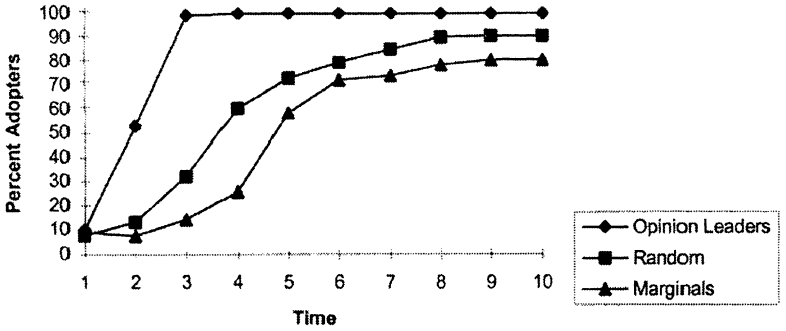
Fortunately, however, centralized networks are usually efficient conduits for information and thus, rather than being impediments to implementation, will generally facilitate diffusion. It may be the case that a network is decentralized and no clear opinion leaders within the community exist. In decentralized situations, the researcher is faced with the challenge of developing opinion leaders who can assume leadership roles for innovation diffusion.

The proposed process of opinion leader identification consists of the following three steps:

1. Identify the 10 percent of individuals within a community who received the most nominations by other members of the community and designate these individuals as the opinion leaders. (This step may be varied to create greater or fewer leaders and can take advantage of other methods of centrality, not discussed in this article, to identify the opinion leaders.)
2. Match opinion leaders to the community members who are closest to them in the chain of information flow. That is, assign each individual to the leader whom he or she nominated or to whom he or she is connected through the smallest number of intermediaries.
3. Assign isolates (individuals who nominated no one and whom no one nominated) to leaders randomly or based on a rule that proportionally allocates isolates to more popular leaders.

The major limitation (or barrier) to the optimal opinion leader matching procedure is the occurrence of extremely centralized networks. In such cases, one or few opinion leaders will be identified and would optimally be paired with all other

FIGURE 2
**DIFFUSION NETWORK SIMULATION WITH DIFFERENT INITIAL ADOPTERS**
**(Threshold set at 15 percent, *N* = 100)**




members of the community. Unfortunately, this result can be impractical for some programs or innovations. For example, if there is only one expert on a topic for an entire organization, the network map will show everyone linked to this one person.

## SIMULATIONS OF OPINION LEADER MODEL

To illustrate the model, we generated hypothetical networks in which the ties between members were randomly allocated. Each network represented 100 people, with each person making seven random nominations. We then simulated diffusion by assuming that each person would adopt an innovation when his or her personal network exceeded a set threshold (15 percent). We then compared three diffusion conditions based on whether the first 10 adopters were (1) opinion leaders, or those who received the most nominations; (2) randoms, or persons chosen at random; or (3) marginals, or those who received the fewest nominations. Each condition was simulated 1000 times and the results averaged over the 1000 runs.

Figure 2 displays the average cumulative adoption curves for the three conditions. If the first adopters are opinion leaders, then diffusion accelerates rapidly and everyone has adopted by time period 3. In contrast, if the first adopters are selected randomly, the middle curve in Figure 2, the rate of diffusion is slower, with only 30 percent of the network having adopted the innovation by time period 3. Similarly, if the first adopters are those individuals who are on the margins (those with fewest nominations), the rate of diffusion is slowest, with only 15 percent of the network having adopted the innovation by time period 3.

As many studies (Becker 1970; Mendez 1968; Rogers 1995) have shown, it is not opinion leaders who are early adopters, but instead marginals or individuals who are bridges to other networks who first adopt an

innovation. When diffusion starts with these individuals, the innovation must percolate through the network before it reaches opinion leaders who are in the position to set the agenda for change. Consequently, critical mass typically occurs late, at time periods 3 through 5 in Figure 2. By intervening directly with the opinion leaders, the lag time between introduction and critical mass is eliminated.

## STRATEGY FOR USING THE OPINION LEADER MODEL

When considering opinion leader model implementation, at least three factors should be considered: (1) opinion leader recruitment, (2) location of training, and (3) timing of training. Getting buy-in from the opinion leaders is very important. These leaders must believe in the innovation that is being diffused and be willing to be active participants in the diffusion process. Leaders may appreciate being recognized as opinion leaders, which validates their position in an organization or community, but this designation may carry with it added responsibilities. As such, compensation for their time may facilitate increased participation.

A second consideration is how and where this learning process should take place. Two options that are most viable are a one-on-one training or a one-to-many training. In the former, the implementing agency would notify each opinion leader of whom he or she is to train or inform and makes an appointment (either formally or casually) to train the learner on the innovation. This informal approach has broad appeal as it promotes a collegial feeling concerning the training. Alternatively, a more formal structure can be created, with the opinion leader meeting with a group of learners for a training or informational session.

The final decision is whether the learning process should be static or dynamic. Will the opinion leader meet once or many times with his or her peer learners? This may be dictated by the innovation being diffused, its complexity, and the risk associated with adoption. For example, opinion leader diffusion of complex medical practice guidelines should consist of one-on-one training and should be accompanied by periodic follow-up. In the diffusion of a simpler innovation, such as organizational reporting procedures, the training may consist of a one-time training session. A third option is to have the opinion leader meet with his or her group of peer learners for a training session and then casually inquire about the learners' compliance in follow-up chance meetings.

Supplemental aids can also be used in the process to trigger conversations. Such aids include informational posters in common areas, or buttons with a related logo to be worn by the opinion leaders (Kelly et al. 1991). These aids can help prompt interpersonal communication, which in turn reinforces the adoption process and accelerates diffusion.

## DISCUSSION

Although logic, computer simulations, and prior experience indicate

that this approach can be successful at accelerating innovation diffusion, a few cautionary notes should be sounded. First, our model and much of the literature assume that individuals are influenced by their direct ties (referred to as a cohesion model of influence [Valente 1995]), while other scholars (Burt, 1987, 1992; Granovetter 1973) have noted that one's position in the network may also influence adoption.[3]

Second, our results may be sensitive to missing data or the inability to interview all, or even most, members of a community. The ability to effectively implement this technique when a full census of the community is not possible is unknown.

Finally, how much opinion leaders enjoy being opinion leaders remains to be seen. While most opinion leaders appreciate the acknowledgment that comes from being recognized as such, some may find it an intrusion or may be resistant to the innovation being proposed.

In spite of these limitations, we believe that this model provides a means to create and chart the optimal path of diffusion within a community. If diffusion cascades from the most central to the more peripheral members of the network, it can do so optimally by moving from the persons with the most nominations to those with the fewest. Such a pathway is the optimal diffusion path. Computation of this trajectory can provide a standard against which to compare actual diffusion processes and provide a useful diagnostic for measuring the relative speed of diffusion.

A second advantage of this model is that in most organizations and communities, different individuals will be seen as opinion leaders in different domains. The opportunity or burden of opinion leadership can be shared by a diverse set of individuals within the community. Over time the community can formulate itself into a dynamic learning community that relies on itself and distributed systems of monitoring to continually enhance its performance.

The influence of interpersonal persuasion in behavior change has been repeatedly noted by scholars for over 50 years. This interpersonal influence is sometimes aided by mass media and other communication strategies and is sometimes independent of them. Rarely, however, has the power of interpersonal influence been systematically incorporated in scientific studies of behavioral promotion and diffusion. Empirical studies designed to prospectively measure the diffusion of innovations and to explicitly observe interpersonal communication patterns would complement the simulations discussed in this article to more fully explain and understand effective diffusion strategies. The challenge for us now is to harness these tools in strategic ways that are meaningful to diffusion efforts designed to promote desired social change.

## Notes

1. The retrospective data are often used to estimate the rate of growth over time and provide the opportunity to compare diffusion rates within and between communities (Valente 1993).

2. Generally, sociograms are drawn with positions of and distances between nodes based on a multidimensional scaling solution (Krackhardt, Blythe, and McGrath 1994).

3. For example, an assistant professor may be influenced by other faculty with whom he or she talks regardless of rank (cohesion), or the assistant professor may be influenced by other faculty who are of his or her rank (structural equivalence), irrespective of whether or not he or she talks to them.

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