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ABSTRACT

Three organizational characteristics of public school districts were studied in order to determine their effects on the adoption of innovations. The sample was 184 school districts in Illinois. A list of 20 innovations was compiled, and the number actually implemented was reported by district superintendents. The ratio of the number of innovations implemented to the number possible for the district was the measure of a district's innovativeness. Each of the three factors investigated had a positive impact on the adoption of educational innovations by the schools. It is suggested that these organizational factors were influential because increased size and complexity generate specialists who search for new solutions to problems within their areas; and environmental complexity and change pose more complex problems, which must be met by more innovation. Policies and practices for promoting innovation in school districts are proposed. A selected reference list is included. (Author)

STANFORD CENTER
FOR RESEARCH AND DEVELOPMENT
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THE ADOPTION OF INNOVATIONS: THE EFFECT OF ORGANIZATIONAL SIZE, DIFFERENTIATION, AND ENVIRONMENT

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Introductory Statement

The Center's mission is to improve teaching in American schools. Too many teachers still employ a didactic style aimed at filling passive students with facts. The teacher's environment often prevents him from changing his style, and may indeed drive him out of the profession. And the children of the poor typically suffer from the worst teaching.

The Center uses the resources of the behavioral sciences in pursuing its objectives. Drawing primarily upon psychology and sociology, but also upon other behavioral science disciplines, the Center has formulated programs of research, development, demonstrations, and dissemination in three areas. Program 1, Teaching Effectiveness, is now developing a Model Teacher Training System that can be used to train both beginning and experienced teachers in effective teaching skills. Program 2, The Environment for Teaching, is developing models of school organization and ways of evaluating teachers that will encourage teachers to become more professional and more committed. Program 3, Teaching Students from Low-Income Areas, is developing materials and procedures for motivating both students and teachers in low-income schools.

In order to encourage improvements in teaching, the school organizations themselves must be concerned with adopting innovations. This study, part of the work of Program 2, deals with the impact of organizational size and the environment on the adoption of innovations in school districts.

Contents

Abstract

Three organizational characteristics of public school districts were studied in order to determine their effects on the adoption of innovations. They were the size of the district (number of pupils), relations between the district and its environment, and the structural differentiation of the district. The sample was 184 school districts in Illinois. A list of 20 innovations was compiled, and the number actually implemented was reported by district superintendents. The ratio of the number of innovations implemented to the number possible for the district was the measure of the district's innovativeness. Each of the three factors investigated had a positive impact on the adoption of educational innovations by the schools. It is suggested that these organizational factors were influential because (a) increased size and complexity generate specialists who search for new solutions to problems within their areas, and (b) environmental complexity and change pose more complex problems, which must be met by more innovation. Policies and practices for promoting innovation in school districts are proposed.

THE ADOPTION OF INNOVATIONS: THE EFFECT OF ORGANIZATIONAL SIZE, DIFFERENTIATION, AND ENVIRONMENT

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There has been a long and distinguished history of research on the diffusion of innovations. For many years anthropologists, sociologists, economists, organization theorists, and social psychologists have been interested in the processes by which technological and social inventions are diffused. The amount of literature on the subject has been enormous and continues to grow at a rapid pace. In 1962, Rogers reviewed over five hundred articles in the area of innovation diffusion, by no means an exhaustive list even at that time. The innovations studied cover a broad spectrum of social life: small pox inoculations (Miller, 1957), educational innovations (Carlson, 1965; Guba, 1968; Keeley, 1968; Knight, 1967; Miles, 1964; Mort and Cornell, 1938; Mort and Pierce, 1947; Ross, 1958), agricultural inventions (Lionberger, 1960; Rogers, 1962), child rearing practices among American mothers (Brim, 1954; Maccoby et al., 1959), the diffusion of medical inventions (Caplow, 1952; Coleman, Katz, and Menzel, 1966), and the introduction of modern machinery into underdeveloped nations (Goldsen and Ralis, 1957). This paper discusses the organizational characteristics that help predict the diffusion of innovations in public school districts.

The topic of innovation diffusion has important implications for public policies. Most of the social legislation of the last fifteen

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years has been related to the diffusion of social inventions--poverty programs, changes in transportation technology, racial integration in public schools, community action programs, urban renewal projects, and a variety of educational innovations. In most of these cases, social strategy has involved governmental financial backing for the spread and implementation of social inventions. In education, for example, the federal government has moved into areas previously of local and state concern, and has implemented many programs.

The mushrooming of program evaluation strategies as a subdiscipline of organization theory is related to the question of whether widely diffused social inventions actually accomplish their purposes. Concern with the evaluation of innovations contrasts with earlier studies, which primarily investigated the rate of innovation and the barriers to innovation, disregarding whether those innovations achieved their objectives. Currently, policy makers are concerned with the factors promoting diffusion, the barriers to it, the patterns of communication surrounding the diffusion, and the evaluation of whether social inventions are accomplishing their purposes. The study of innovation diffusion has great interest for social scientists, especially when the innovations are linked to social policy issues.

The Individualistic Bias in Research on Innovation

Up to this point the bulk of the research on innovation diffusion has been individualistic, i.e. it has focused on a single technical invention (e.g., new fertilizer or a new medicine), studying the factors that cause an individual user (e.g., a farmer or a physician) to adopt or reject that invention. Usually the dependent variable concerns individual adopters: Will a farmer adopt a new fertilizer, or will a physician start using a new drug? Sometimes the rate of adoption among a group of people is the dependent variable: "How fast will individuals with X characteristic adopt the innovation as compared to individuals with Y characteristic? Not only is the dependent variable almost always an individual, but, not surprisingly, the independent factors expected to produce the behavior are typically individualistic. For example, are the adopters young or old, traditional or modern, rich or poor, opinion leaders or followers, of high social status or low, at the center of a communications network or isolated? (See Rogers and Shoemaker, 1971.)

In few cases are complex organizations and their problems treated in the diffusion literature, despite the fact that today most major social policy inventions are used by complex organizations rather than by individuals. Educational inventions, community action projects, improved technologies in industry, and new health delivery systems are examples of social inventions adopted primarily by complex organizations not by individuals. Unfortunately, the literature on innovation provides us with very little help in this area. In fact, Rogers' monumental study (1962) of innovation summarized the conclusions of research on 52 major propositions--not one of which referred to a complex organization as the innovation adopter or to organizational features as independent variables affecting the process of adoption.

The focus on the individual as the prime analytical unit in diffusion studies is not surprising, for even organization theorists have commonly used individualistic factors in discussing organizational change. The "human relations" school of organization theory has virtually preempted the study of organizational change. Most books whose titles suggest that they deal with organizational change--for example, Bennis's _Changing Organizations_ (1966)--actually are more concerned with changing individuals within organizations. The two organizational change articles (Shepard; Leavitt) in March's _Handbook of Organizations_ (1965) examine individualistic and social psychological questions, not questions of macro-organizational change. While planning a course on organizational change, the authors of this article had a research assistant derive from sociological journals a bibliography of 109 items on organizational change. Inspection showed 84 of the 109 articles to be actually about changing individual attitudes or work habits within organizations, not about changing the organizations themselves. In short, the focus upon individual adopters of innovations in the research on diffusion is a logical complement to the individualistic focus in other areas of organizational change.

Why have the analysis of innovation diffusion and the study of organizational change taken this individualistic bent? There are probably three answers. First, many early diffusion studies really did choose the appropriate level of analysis, since the innovation they were concerned about could be adopted by a single decision maker--a farmer, a physician, or a family. Second, the individual was often inappropriately selected because most researchers in these investigations were psychologists or social psychologists, trained by their disciplines to focus on the individual. It would have taken a major conceptual revolution for these researchers to have analyzed organizational decision making and organizational factors as elements in the diffusion process. Third, the selection of individuals as the unit of analysis was often done for policy reasons: that is, people concerned with the diffusion of innovation had practical results in mind, such as rapid diffusion of particular inventions. It was assumed that the most manipulable factor was an attitude, a factor which could be changed by persuasion, evangelistic appeals, and social pressure. Consequently, the search for a manipulable factor led to the selection of the individual as the unit of analysis.

The Need for Organizational Factors in Studies of Diffusion

Although much of the innovation diffusion tradition is based upon individualistic perspectives, we believe organization theorists and other social scientists need to consider seriously additional sociological variables that may affect the diffusion of innovations. Most major policy decisions about social inventions are now made by complex organizations, committees, and community action groups, rather than by individuals. The shift in focus from single, mechanical, technological inventions to large-scale social innovations requires a new perspective on the problem of innovation diffusion. In short, we are arguing that

(1) organizations are now the major adopters of social inventions, and (2) organizational factors and dynamics are the major independent variables influencing both the amount and the rate of adoption. This is a drastic reshaping of the intellectual tradition surrounding the diffusion of innovation.

Some researchers already have begun focusing upon organizational characteristics. In the study of industrial innovation, for example, research has been done on organizational decision making as it affects the adoption of particular new processes or inventions (see Knight, 1967). Moreover, some educational innovation research has stressed the importance of organizational processes in adopting innovations (see Ross, 1958, for a summary of over 150 articles on educational innovation, including a few using organizational variables). Mort's research at Columbia Teachers College (1938, 1947) focused on school systems as innovation adopters and upon characteristics of the district and its environment as independent variables. Mort's research concluded that the financial state of the district was a major factor in promoting the adoption of innovation. Baldridge (1971) studied change processes at New York University, focusing on structural, political, and environmental determinants of large-scale organizational change. In short, there are a few researchers who have turned to organizational features as the causes of change and innovation.

A shift to organizational variables in studying innovation could focus on many different factors, some readily controlled by decision makers: financial commitments, deliberate searches for new innovation, decentralization to foster innovation. Other organizational factors are not easily manipulated and, in fact, are rarely the subject of conscious decision making: size, geographic region, openness to environmental influence. This paper concentrates on the latter set, showing how the adoption of educational innovations in school districts is affected by three major organizaional characteristics: organizational size, structural differentiation, and environmental relationships.

By arguing that these organizational variables are critical, we are not rejecting the idea that individual characteristics of organizational leaders influence the adoption of innovations. Nor are we suggesting that the three particular organizational features selected explain all of the differences in change processes. We know, for example, that political processes, coalitions among interest groups, and financial arrangements may be just as critical in determining what innovations are adopted and when. Our prime attempt is to show that, in addition to these other factors, three important determinants of innovation adoption can be isolated.

The Research Process

This study of innovation adoption examined 264 school districts in the state of Illinois. The first criterion of sample selection was that at least one school district in each county should be represented, since most of the environmental data critical to the analysis could be gathered only on a county basis. Second, larger school districts were chosen, since districts consisting of one or two schools could hardly be called "complex" organizations. For this reason, we limited the sample to elementary districts of over 1,000 students and secondary districts of over 500 students. With these two criteria in mind, we selected the sample of 264 districts. When more than one school district within a county met the criteria, we proportionately sampled from those districts randomly. Therefore, the sample does not represent a random sample of all school districts, but is a purposely drawn cross-section of counties, as well as large school districts of fairly complex structure.

Having drawn the sample, we collected data from three sources. (1) A questionnaire went to each district superintendent. After one follow-up letter, we received responses from 81 percent of the sample; since not all the questionnaires were complete, the usable sample was 184 districts. (2) The division of finance and statistics of the Illinois Office of the Superintendent of Public Instruction provided punched card records of enrollments and other school district characteristics for each of the districts involved. (3) Environmental and demographic data for each district were drawn from the Census Bureau's <u>County and City Data Book</u> and the <u>Census of Governments, 1962</u>. A problem arose in gathering environmental data on the districts because the only available demographic and population data were based on counties. Since some school districts were located in more than one county, we used the information about the county in which the school district offices were located. Although districts and counties were not a hundred percent coterminous, this procedure gave a reasonably accurate estimate of the population characteristics of the district. The Chicago School District was omitted from the analysis on the assumption that it would be grossly atypical.

The Dependent Variable: Innovations Adopted

The dependent variable was operationalized by having superintendents specify which items from a list of twenty innovations were implemented in their districts and when. The list was compiled from an educational innovations survey conducted in Illinois by Dal Santo (1968). Dal Santo used a reputational survey approach to identify a dozen Illinois school districts classified as "innovators" by agreement among 89 school superintendent respondents. Superintendents of these innovative school systems were then asked to nominate "significant" innovative methods or programs for inclusion in a compendium of educational innovations. This technique of compiling a list of innovations seemed particularly appropriate, since it is reasonable to assume that an organization itself can determine whether or not an innovation is "significant" for its own needs. The resulting list of 38 innovations Dal Santo categorized as organizational, technological, or curricular. For the most part the twenty innovations used in our study includes items from Dal Santo's organizational and curricular categories. The list follows:

Independent study (or contract learning) program
Flexible scheduling

Team teaching
Independent study centers (or learning labs)
Differentiated staffing

Paraprofessional (volunteer) staffing
Nongraded program
School-within-a-school organization
Curriculum materials publication center
Remedial reading laboratory

Multi-media resource center
Individually prescribed instruction
Gifted student program
Black studies program
Pre-formal or experimental kindergarten

Dual enrollment (shared time) program
Cooperative and/or Regional vocational
    education program
Student-teacher videotaping
Driver education simulators and/or
    multi-vehicle driving range
Data processing education program

The ratio of innovations implemented to the number possible for each type of school district was calculated as a measure of innovativeness. Some districts could not adopt certain types of innovations; elementary districts could adopt [illegible] secondary 19, and combined districts could use all 20. The fact that innovations were actually put into operation was considered presumptive evidence that the innovation process had been successfully completed, i.e., that search and adoption had occurred.

The Independent Variables: Factors Promoting Innovation

We assume that a wide variety of factors promote innovation. The many studies of individual characteristics of decision makers are relevant here, for the insightfulness, dynamism, and aggressiveness of an organizational leader can be critical in determining whether innovation occurs. In fact, Carlson (1965) shows that whether or not a district adopts innovations is highly influenced by the personal characteristics of a district superintendent of schools--his place of origin, his term in office, his age, his cosmopolitan characteristics, and his professional standing.

Political dynamics also influence adoption rates. Certainly, the political climate of a community in which a school district is located is a major factor. Do the taxpayers show willingness to pay for educational innovation, or are they more interested in keeping the tax rates low? Are there conservative interest groups that fight change? Inside the school district itself the internal dynamics have great impact on adoption rates. Are teachers interested in new techniques? Are controversial curricular innovations opposed? Do cliques of older teachers block innovations by younger groups? Is a teacher's union opposed to innovations that might reduce the number of teachers in a district? Financial stability and wealth are an additional part of the equation, as Mort and his associates consistently found. Clearly, a host of factors may influence whether a district decides to adopt various innovations or to reject them.

Of these possible independent factors, we chose three structural characteristics that we expected to have major impact on a school district's innovativeness. The first was "differentiation," the segmentation of the district into organizational units and administrative positions; the second was size, the number of pupils in the district; and the third was "environmental variability," the demands and pressures on the school district caused by urbanization, population density, and other demographic characteristics of the community. Figure 1 is a simplified diagram of the hypothesized relationships. Of course, each variable listed has a number of indicators, but including them all would have produced an unnecessarily complex diagram.

The following sections (a) state hypotheses showing the influence of each of the three variables on innovation, (b) state an argument for why we believe these effects occur, (c) list the various indicators of each of the variables used in the study, and (d) report the findings. Table 1 shows a complete list of variables, indicators, and sources for the factors related to innovation. Table 2 is the basic correlation matrix for all indicators.

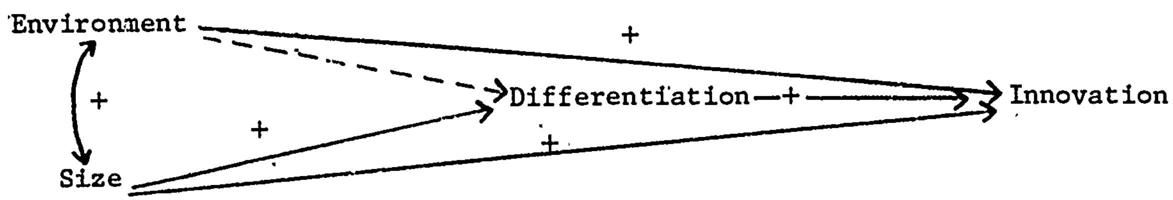

Figure 1. Simplified diagram of hypothesized interrelations. (This is a very simplified path diagram. The complete diagram with all indicators is more confusing than enlightening, so we have relied on Table 3, the complete set of all path coefficients, to tell the detailed story while this simplified diagram shows only the general relationships.)

TABLE 1

List of Variables, Indicators, Definitions, and Sources

Variable Name	Indicators	Definition	Source	Average Score on Variables for HIGH Innovative Districts	Average Score on Variables for LOW Innovative Districts
Structural Differentiation	Organizational Components	The number of programs & positions formally organized in each district.	Superintendent's Questionnaire	12.263 average # admin. positions	8.202 average # admin. positions
	Specialization	The number of full-time equivalent administrators assigned to the programs reported for Organizational Components.	"	25,095 average FTE administrators	13,888 average FTE administrators
	Conflict Prevention Devices	The sum total of district's use of (a) policy defining the jurisdiction & responsibilities for each major dept., (b) rules governing interdepartmental arrangements, (c) job descriptions for administrative positions, or (d) an organization chart.	"	2.884 policy systems	2.101 policy systems
	Conflict Resolution Mechanisms	The formal social interaction channels that dissipate or mitigate tensions; measured by the number of district-level ad hoc policy committees (weighted 1) & standing policy committees (weighted 2).	"	9.165 policy committees	7.741 policy committees
Size	Number of Students	District average daily attendance for 1968-69.	State Education Dept.	5,335 pupils	2,561 pupils
Environmental Variability	Population Density	Density of population per square mile within each county (more density = more variability).	Census Bureau	2,134 people per sq. mile	1,135 people per sq. mile

TABLE 1 (Continued)

Variable Name	Indicators	Definition	Source	Average Score on Variables for HIGH Innovative Districts	Average Score on Variables for LOW Innovative Districts
	Urbanization	The percentage of the county population classified as urban by U. S. Census Bureau (more urban = more variability).	Census Bureau	73.9% urban	58.2% urban
	Percent Nonwhite	The percentage of nonwhites in each county (more nonwhites = more variability).	"	7.789% nonwhite	4.775% nonwhite
	Local Taxing Agencies	The number of public taxing agencies within the county in competition with school distrcits for tax dollars (more agencies = more variability).	City and County Data Book	209.4 agencies	136.4 agencies
	Educational Expenditure Ratio	The ratio of total educational expenditures to total direct general expenditures for local government. Inversely related to environmental variability, since a county in which education is the largest public endeavor would have a high educational expenditure ratio but few other activities (lower ratio = more variability).	"	48.44% public funds go for education	52.84% public funds go for education
	Percent Home Ownership	A measure of transiency in the environment (less ownership = more variability).	Census Bureau	61.28% own homes	65.31% own homes
Innovations Adopted	Innovations	Of those innovations possible for a district, what percent had it adopted?	Superintendent's Questionnaire	38% or more of possible innovations adopted = HIGH	Less than 38% possible innovations adopted = LOW

TABLE 2

Basic Correlation Matrix

	Indicators	Differentiation 1	2	3	4	Size 5	Environmental Variability 6	7	8	9	10	11	Innovation 12
1	Organizational Components	1.00	.805	.184	.318	.680	.094	.272	.119	.115	-.127	-.131	.454
2	Specialization		1.00	.194	.221	.911	.089	.304	.104	.110	-.109	-.099	.476
3	Conflict Prevention			1.00	.162	.135	.159	.201	.141	.165	-.149	-.123	.241
4	Conflict Resolution				1.00	.191	.120	.118	.132	.115	-.140	-.100	.303
5	Size					1.00	.119	.351	.121	.139	-.152	-.126	.456
6	Density						1.00	.762	.893	.990	-.882	-.878	.296
7	Urban							1.00	.666	.803	-.715	-.595	.358
8	Percent Nonwhite								1.00	.883	-.787	-.839	.246
9	Agencies									1.00	-.856	-.860	.306
10	Expenditures										1.00	.799	-.262
11	Home Ownerhsip											1.00	-.267
12	Innovations Adopted												1.00

Note: Any correlation of .15 or over is significant at the .05 level.

The Impact of Differentiation on Innovation

Proposition 1: The greater the structural differentiation of the organization, the greater the adoption of innovations.

In order to accomplish their tasks, complex organizations are typically subdivided into specialized units. Generally, these units are formed around components of the organization's task, with each specialized unit manned by administrators designated to handle specific jobs. The splintering of the organization allows for greater efficiency, if the specialized units are effectively coordinated, but it frequently leads to conflict, because the components may require different resources, may have difficulty coordinating with other components, and may have widely divergent goals. Therefore, it is necessary that a system of coordination be developed to oversee the linking of components. Organizations traditionally have used a hierarchical pyramid for coordination, adding conflict-resolving mechanisms such as policy-making committees and coordination councils.

Indicators

In this study the extent of differentiation was measured by four indicators: (1) the number of administrative positions in a school district office; (2) the number of full-time-equivalent (FTE) administrators filling those positions; (3) the number of conflict-preventing mechanisms such as organization charts, job descriptions, and clearly defined unit responsibilities; and (4) the number of conflict-resolving mechanisms, measured by the number of standing and ad hoc policy committees designed to coordinate units. In each case the information on differentiation was gathered from the questionnaire administered to superintendents.

Argument

Why do we believe that increased differentiation will lead to increased innovation? Greater differentiation promotes search and adoption activities which, as discussed by March and Simon (1958), are the critical stages in organizational innovation. That is, increased structural differentiation results in a large number of specialists, each perceiving different problems from their particular frame of reference and from their particular unit's point of view. Because they see different problems and because they handle specialized tasks, they initiate searches for more efficient techniques to accomplish their goals. This diversity, however, tends to produce high levels of conflict, as separate but highly interdependent components interact. These conflicts--over both resources and goals--must be resolved through mechanisms for integration, such as hierarchical decision making or joint policy making through coordinating committees. Thus, both differentiation, in terms of structural units, and integration, in terms of coordinating mechanisms, help promote innovation--the first by creating specialists whose job is to seek new solutions, and the second by providing mechanisms for overcoming conflict (see Lawrence and Lorsch, 1967). As the number of components and subcomponents increases, the quantity of alternatives and solutions also increases, in response to perceived unique problems. The diversity of incentive systems and task structures resulting from differentiation is another major reason for increased innovation. In short, increased structural differentiation, coupled with effective integration mechanisms, is likely to result in high rates of innovation.

Results: The Effect of Differentiation on Innovation

From a wide variety of analyses, it is apparent that increasing differentiation does lead to increased innovation. For example, look at Table 1. When districts are separated into high adopters and low adopters, it is obvious that in every case the high adopters are structurally more complex than the low adopters. There are nearly 50 percent more administrative positions; there are twice as many full-time administrators; there are about 25 percent more conflict-preventing policy systems, and a significantly greater number of conflict-resolving committees. Table 2, the basic correlation matrix showing the relationship among all variables, substantiates the same relationships:

the rate of innovation is correlated with the number of components at .45, specialization at .48, conflict prevention at .24, and resolution at .30. Table 3 is a master chart containing all the multiple regression analyses. Part I shows the amount of variance in innovation explained by the four differentiation variables. The impact is clear and strong: R is .534 while R^2 is .285.

Table 4 gives standardized Betas. Surprisingly, it shows weak relations between differentiation and innovation; that is, when the joint impact of other variables is artificially taken out, differentiation does not seem to make much difference. However, this is easily explainable. Size and differentiation are highly correlated, and each has an impact on innovation. However, when the impact of size is artificially subtracted from the impact of differentiation, it appears that differentiation no longer affects innovation. This is only an artifact of the statistical manipulation; it is not a case of "spuriousness" but a case of "interpretation." Complexity is a true intervening variable, and helps explain why size has its impact. In this sense the Betas are misleading, for in reality size and complexity always act together, not separately. In short, the weight of evidence clearly shows that differentiation positively affects innovation.

The Impact of Size on Innovation

> Proposition 2: Increased size of an organization leads to increased amounts of innovation adoption.

Organization theorists have always assumed that size is a critical factor in any analysis of a formal system. Large and small organizations may have different financial bases, varying levels of structural differentiation, dissimilar economies of scale, and increased opportunities to interact with their environments through client relationships. In this study size was measured by the average daily attendance of pupils in a given district.

TABLE 3

Multiple Regressions

I. Differentiation Variables: Impact on Innovation

	R	R^2
Specialization	.476	.227
Resolution	.513	.263
Integration	.529	.280
Components	.534	.285

II. Environmental Variability: Impact on Innovation

	R	R^2
Urban	.368	.136
Ownership	.373	.139
Nonwhite	.379	.143
Expenditure	.381	.145
Agency	.381	.145
Density	.385	.148

III. Environmental Variability: Impact on Differentiation Indicator = Specialization)

	R	R^2
Urban	.304	.092
Agency	.378	.143
Ownership	.400	.160
Expenditure	.402	.161
Nonwhite	.403	.162
Density	.404	.163

IV. Size and Environmental Variability: Combined Impact on Differentiation (Indicator = Specialization)

	R	R^2
Size	.933	.871
Density	.934	.871
Urban	.934	.872
Nonwhite	.934	.872
Agency	.934	.873
Expenditure	.935	.874
Ownership	.936	.876

V. All Independent Variables: Impact on Innovation

	R	R^2
Components	.471	.222
Specialization	.538	.289
Prevention	.551	.303
Resolution	.578	.334
Size	.596	.356
Density	.614	.377
Urban	.615	.378
Nonwhite	.619	.383
Agency	.620	.385
Expenditure	.624	.390
Ownership	.638	.407

TABLE 4

Beta Weights: Path Coefficients for All the Exogenous Variables Against the Two Endogenous Variables: Differentiation and Innovation

		Differentiation				Size	Environmental Variation					
		Resolution	Prevention	Specialization	Components	Size	Ownership	Expenditure	Agency	Nonwhite	Urban	Density
Differentiation	Components	--	--	--	--	.686	.006	.030	.122	.055	.112	-.236
	Specialization	--	--	--	--	.936	.052	.040	.034	.032	.054	-.122
	Prevention	--	--	--	--	.135	.033	.084	.059	.073	.036	.071
	Resolution	--	--	--	--	.064	.007	.052	.003	.012	.189	-.026
	Innovation	.172	.112	.054	.117	.332	.180	.069	.140	.105	.018	.374

Note: Underlined coefficients are those predicted by our path model, Figure 1. The others were not hypothesized to have an impact.

Argument

Increased size increases innovation because of two interrelated types of dynamics. First, there is a direct effect, as increased size increases innovation; and second, there is an indirect effect, as size increases differentiation, which in turn increases innovation.

> Proposition 2A: Increased size directly causes increased innovation.

Increased size creates problems of coordination, control, and management which in themselves demand innovative practices. Moreover, and increase in size often makes formerly minor problems wholly unmanageable, and thus forces innovative attempts at solution. For example, a small school district is unlikely to have enough handicapped students to initiate special programs for them, but a large district is likely to have enough students to necessitate innovative practices. In addition, increased size can lead to other kinds of heterogeneity, producing peculiar and unique problems. Further, in a school district, increasing the size expands the possibilities for interacting with the environment by adding new clients who may make special demands. Increased problems of control, critical masses of specialized problems, higher levels of heterogeneity, and increased opportunity for environmental relationships--these are some of the dynamics by which size directly affects the problem of innovation.

> Proposition 2B: Increased size increases differentiation, thereby indirectly affecting innovation.

Many studies have shown that increases in size are directly related to increases in differentiation. Probably the most influential of these studies was Blau's analysis of social service agencies (Blau, 1970), in which he found a correlation of .91 between size and differentiation. In our analysis we found correlations varying from .68 to .91 depending on the measure of differentiation used. In addition, in another study on universities (as yet unpublished) we found correlations between size and differentiation varying between .70 and .93. The argument of the studies cited, and of this one, is that increasing size leads to a multiplying set of task problems; the organization handles these problems by subdividing into specialized units to deal with the tasks. The link between size and differentiation is important for the study of innovation. If differentiation has a major impact on innovation, and if size is a major determinant of differentiation, then size has a strong indirect effect on innovation.

Results: The Impact of Size on Innovation

We suggest that size is related to innovation in two ways: directly, and indirectly through its impact on differentiation. The results of the study strongly support both hypotheses. Table 1 shows that the innovative districts in the sample have an average of 5,335 pupils, while districts with low rates of adoption have 2,561. This is obvious in the correlation matrix as well, where the relationship between size and innovation is .46. The hypothesis that size increases differentiation is well supported by two indicators of differentiation, with the correlation between size and the number of organizational components being .68, and the correlation between size and specialized administrators .91. The relationships to mechanisms for preventing and resolving conflict, however, show weak correlations of .13 and .19. In Table 4 the standardized Beta coefficient between size and innovation is .332. Thus, it appears that size has more impact on structural differentiation than on coordination and conflict-resolving mechanisms.

The Impact of Environmental Variability on Innovation

> Proposition 3: The greater the environmental variability, the greater the tendency to adopt innovations.

Organizations obtain inputs of various kinds from their environments, process those inputs, and feed back finished products. These inputs include demands on the organization. School districts, in particular, have permeable boundaries and are extremely susceptible to their clients' influence (Bidwell, 1965; Sieber, 1968). The educational tradition of community interest and influence continues up to the present. Suburban, middle-class communities, have always made high demands on their school districts, and recently minority and low-income neighborhoods have organized "community control" movements.

The dynamics of interest groups and the pressure brought by suburban areas and community control advocates are almost impossible to measure in a broad survey. Consequently, we had to assume that demographic data such as population density, urbanism, and the relationship between the school district and other community agencies were reasonable indicators of the variability existing in the schools' environment. We expected that heterogenenous and changing environments would pose unique problems for school districts, causing them to implement many of the innovations on our list. Therefore, we selected districts according to four factors indicative of environmental variability: population density, urbanization, the percentage of nonwhites in the district, and the amount of home ownership.

In addition, we looked for two factors that basically dealt with environmental competition between the school district and other governmental agencies: the number of local taxing agencies competing for public money, and the ratio of school expenditures to all government expenditures. These two variables essentially examine the district's place relative to other governmental functions of the county. We assumed that more agencies competing for the same funds would represent an increase in both environmental variability and complex demands on the school system. Similarly, the higher the schools' share of the government budget, the more simple the governmental structure; otherwise other agencies would be successfully competing for more of the public pie. In either case--an increase of other governmental agencies, or a reduction of the budget for education--the environmental setting of the school district was relatively complex.

> Proposition 3A: Increased environmental variability increases innovation directly.

<u>Argument</u>

A heterogeneous and changing environment is likely to have more specialized problems than a homogeneous and relatively stable environment. Consequently, we expected that complex environments would lead to more problems for the school district and to innovation.

> Proposition 3B: Environmental variability increases differentiation, hence indirectly increasing innovation.

Argument

Thompson (1967) and Lawrence and Lorsch (1967) argue that organizations with complex environmental demands tend to create specialized units to deal with inputs from the environment. In other words, they usually subdivide around special problems, in this case, a series of diverse inputs from the environment. As proposition 1 argued for an increase in innovation when differentiation increases, it follows that if environmental complexity increases differentiation, there may be a strong indirect effect on innovation.

Results: The Impact of Environmental Variability on Innovation

Hypotheses 3A and 3B predict both a direct effect on innovation, and an indirect effect by the environment's promotion of structural differentiation. To examine the direct effect, six indicators of environmental variability were used. In Table 1 all six indicators show the predicted relation to innovation (expenditure and home ownership should score low in the high innovative schools to match our predictions). Four of the six are strong, with high innovation adopting districts having nearly double the density, about 50 percent higher urbanization, about 75 percent higher rates of nonwhite, and almost twice as many other governmental agencies in a complex environment. The differences on expenditure rates and home ownership are not as strong, but they are clearly in the predicted direction. The correlation matrix in Table 2 backs up these same relationships with a low of .25 (between nonwhite and innovative) and a high of .37 (between urban and innovation adoption). Part II of Table 3 shows that in a multiple regression analysis the combined effect of all environmental variability variables on innovation is a multiple R of .385 and an R^2 of .148.

As for the impact of environmental variability on differentiation, Table 2 shows low correlations between the various indicators of each variable. The one exception is a moderate relation between urbanization and the differentiation measures. However, there does seem to be some cumulative effect when all the environmental measures are entered simultaneously in a multiple regression analysis against specialization as the dependent variable. In Part III of Table 3 the multiple R is .404 and R^2 is .163. In general, however, hypothesis 3B, that environmental variability increases the structural differentiation of an organization, does not seem well supported. This is a surprising negative finding in light of the arguments in the literature and in view of the plausibility of the argument that increased environmental demands should pose special problems around which subunits would be formed. At this time we have no explanation, but we remain stubborn in our belief that environmental variability should affect differentiation--even if the data will not cooperate.

The Combined Effects of Differentiation, Size, and Environmental Variability

Each independent variable acting alone seems to have had significant impact on the innovation rates of the school districts. What were the combined effects? In general, we suspect that the independent variables are intercorrelated, but that there is also a cumulative, independent impact on the amount of innovation. No single factor can account completely for innovation, but taken together, a significant amount of the variation may be explained. We can show these combined effects in several ways.

First, Table 5 is a complex cross-tabulation of four variables, showing the joint and independent effects of the three independent variables on innovation rates. The table shows the mean innovation rate for each subcategory of size, environmental variability (indicator = urbanization), and differentiation (indicator = specialization,

TABLE 5

Mean Percentage of Innovations Adopted in 184 School Districts Controlled by Size, Differentiation, † and Environmental Variability ††

	Large Districts				Medium-Sized Districts				Small Districts				
	Environmental Pressure				Environmental Pressure				Environmental Pressure				
Differentiation	High	Med	Low	Marginal	High	Med	Low	Marginal	High	Med	Low	Marginal	Master Marginal
High	a 54.7 (20)	b 52.5 (22)	c 55 (1)	53.6 (43)	j 47.5 (2)	k 35.0 (2)	l 30.0 (3)	36.4 (7)	s ___	t 53 (1)	u ___	53.0 (1)	51.2 (51)
Med	d 44.2 (13)	e 26.6 (5)	f ___	39.3 (18)	m 43.9 (18)	n 32.7 (14)	o 36.0 (11)	38.3 (43)	v 83.0 (1)	w 32.8 (4)	x 23.4 (9)	30.2 (14)	37.0 (75)
Low	g ___	h ___	i ___		p 33.1 (8)	q 30.0 (2)	r 40.0 (1)	33.2 (11)	y 39.0 (2)	z 24.7 (10)	aa 24.3 (35)	25.0 (47)	26.6 (58)
Marginals	50.5 (33)	45.7 (27)	55.0 (1)	49.3 (61)	41.1 (28)	32.7 (18)	35.2 (15)	37.2 (61)	53.7 (3)	28.3 (15)	24.0 (44)	26.7 (62)	37.7 (184)

† Specialization as indicator

†† Urbanization as indicator.

††† Mean percentage of innovations adopted for environmental variability alone: HIGH = 46.6 (64), MED = 38.4 (60), W = 28.0 (60).

the FTE of administrators). This is a complex table and requires careful examination; the cells in the table are lettered to facilitate discussion. First, it is clear that different levels of size influence innovation: 49.3, 37.2, and 26.6 are the innovation rates for large, medium, and small school districts respectively. Second, the far right-hand marginal figures show the differences in innovation rates as they are affected by differentiation: 51.2, 37.0, 26.6 are the innovation rates for high, medium, and low levels of differentiation. Third, different levels of environmental variability affect innovation in different ways, with high variability producing 46.6 percent innovation rate, medium producing 38.4, and low 28.0 (see n. 3).

The important question is whether each of these variables continues to have independent effect when the other factors are controlled. Does size still have impact when the other factors are controlled? First, compare cells across the three main sections of the table, that is, compare cell a with j with s; b with k with t; and c with l with u, etc. Moving from high to low size lowers the innovation rate of the district, just as when other factors are not controlled. This is true in almost every comparison, and in the few contrary cases there are large sampling error possibilities because there is only one case in the cell.

Does environmental variability (as measured by urbanization) still have impact when other variables are controlled? In this case we simply compare cells by rows within each section of the table; that is, we compare cells a, b, and c; d, e, and f; j, k, and l, etc. Again, the same essential pattern occurs, with innovation rates going down as the level of urbanization goes down--even when other factors are controlled.

Finally, does differentiation (measured by specialization) still have an impact on innovation when other factors are controlled? Read down the columns within each section of the table, that is, compare a, d, and g; b, e, and h; c, f, and i, etc. With the exception of the l, o, r comparison, examination shows that decreasing differentiation leads to decreasing rates of innovation. In short, Table 5 indicates that each of the independent variables has both an independent effect and an interactive effect.

The multiple regression analysis, reported in Table 3, supports the general conclusions of the cross-tabulation. When all independent variables are run against innovation (part V of the table), the multiple R is .638 and the R^2 is .407. Together the variables explain over a third of the variation in school district innovation adoptions. To be sure, many factors influence innovations--personality issues, financial questions, technology questions, and interest group pressures, for example. However, to discover that three clusters of variables explain such a large proportion of the variance is indeed a significant finding.

Finally, when we examine Table 4 containing the path coefficients (standardized Beta Weights) the picture is essentially the same. Even when all other factors are controlled, size is still highly correlated with structural differentiation (with organizational components = .686, with specialization = .936), but not with the integration types of differentiation (conflict prevention and resolution). Size still correlates significantly with innovation (Beta = .332). Environmental variability measures do not correlate well with the differentiation measures, but density correlates well with innovation (Beta = .374). The fact that the other environmental variables do not correlate well with innovation after density has accounted for its variation, is easily understandable, since it is clear from the simple correlations in Table 2 that they are all highly interrelated. In short, the analysis of the Betas reaffirms the general conclusions offered by other analysis procedures.

It is possible to represent the impact of three independent variables on innovation adoption with a simplified causal model (see Figure 1). The model graphically restates what we have already said in words: that size increases both differentiation and innovation, environmental variability increases innovation, and differentiation increases innovation. Size seems to have an enormous impact on differentiation, but at the same time, an independent impact on innovation. Environmental variability, on the other, seems to have a direct impact on innovation and a much smaller impact on differentiation; in fact, the hypothesis that environmental variability increases differentiation seems very doubtful.

Summary and Conclusions

In summary, our data help us argue that a large, complex school district with a turbulent, changing, and heterogeneous environment is probably much more innovative than a small, simply organized district with a relatively stable, homogeneous environment. The basic logic behind this argument concerns a "demand structure."

1. Size makes demands about coordination, control, and complexity to which a district must respond.
2. Differentiation and structural complexity produce cadres of specialists concerned about carrying out their specialized tasks and seeking means for handling them.
3. The environment surrounding a district makes numerous demands, depending upon its heterogeneity and stability.

The structural characteristics of school districts are very powerful explainers of innovative behavior. Certainly, they cannot replace other interpretations such as the personality characteristics of administrators or the unique character of the innovations themselves, but when coupled with these alternative explanations, the structural variables account for a great deal of the innovative behavior.

These findings have a number of serious policy implications for people who wish to change in educational or other types of organizations. First, the findings argue that large size is an important factor in innovation and that critical masses of organizational participants are needed to generate a demand structure that facilitates innovation. School administrators throughout the country have been arguing for years that consolidation of small districts would result in efficiencies and economic benefits; our results suggest that consolidation also promotes innovation.

Second, the findings suggest that differentiation and structural complexity are critical for innovation. In many ways relatively undifferentiated and smaller school systems do not have enough problem-solving capacity or enough specialized experts to promote innovative behavior. For this reason deliberate attempts at differentiation might be expected to produce higher levels of innovation. For example, specialized "change agents" could be employed to disseminate educational innovations and technology. Other strategies, such as district level agencies to gather data and process information, as well as district-wide committees on innovation, might foster innovation through deliberate differentiation and specialization.

Finally, our data suggest that environmental variability is a critical factor in promoting innovation. Consequently, an organization desiring innovation could promote that process by opening channels of communication between itself and its client environment. For example, serious innovation has often occurred when community control advocates have gained enough power to have significant input into school districts. In effect, we are arguing that a school district which wants to be innovative must make itself more vulnerable by deliberately creating channels of communication and influence to its external environment.

We believe that the findings demonstrated theoretically and empirically in this article can readily be translated into policy decisions that could promote innovation practices in school districts. Of course, as organization theorists we are eager to argue that these same dynamics can exist in other complex organizations, for they, too, must deal with differentiation, size, and environmental variability. There is every reason to suspect that school districts are not unique, and that other organizations will experience the same types of innovation processes.

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