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ABSTRACT

The diffusion of three types of innovations in secondary schools in Canada are investigated: (1) program organization (time scheduling); (2) program content (courses for special students); and (3) physical environment (conservation measures). Analysis focused on the rate of innovations as estimated by a mathematical model of the adoption process, the percentage of schools adopting, and explanations for variations in these two statistics. First, the role of regulations and legislation in the diffusion of time schedules appeared substantial. Second, the values of provincial societies seemed to account for the variation in the diffusion patterns of providing for students with special needs. Third, economic factors clearly accounted for regional differences in rates of adoption and degrees of penetration of energy conservation measures; both were related to the cost effectiveness of a given practice. The economic growth of Western Canadian provinces encouraged liberalization, and wealth existed to fund experimental programs. The economic difficulties of Eastern Canada fostered rapid innovation in conserving energy, but tended to slow innovation in education and reinforce traditional conservatism. (RL)

Regulations, Money, and Culture: Three Explanations for Differing Rates of Diffusion of Educational Innovations in Canada

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1.0 INTRODUCTION

One of the major advances in the study of the diffusion of innovations in recent years has been the development of mathematical models that make it possible to calculate rates of diffusion, to estimate how long it will take for a given innovation to diffuse, and to estimate early in an innovations life cycle how many adopters it will eventually have. No one model has been shown clearly superior, but those by Bass (1969), Mansfield (1961), Tebbutt and Atherton (1979), and Lawton and Lawton (1979), have all been shown to give good estimates of parameters that characterize the life cycle of an innovation. Complementing this work, in which it is assumed that adoption occurs at random, is that of researchers such as Rogers (1962), and Martin and Swan (1979), which focusses on sociological and organizational factors that affect the pattern and rates of adoption.

The mathematical and sociological lines of research can be joined by mating the techniques of the modellers with the insights of sociologists in order to explain differences among rates of adoption. An early, and classic, study combining these approaches is Griliches' (1957) enquiry into economic, social, and organizational factors affecting the rate at which hybrid corn seed was adopted by farmers in the United States. The present study has similar objectives, but deals with a different class of adopters--secondary schools in Canada--and a more diverse set of innovations--ranging from scheduling innovations to energy conservation measures.

Mathematical models of diffusion are, in one sense, logically opposed to purely social models of diffusion in that the former require the assumption that all adopters, or

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potential adopters, form a homogeneous population whose members will, with some fixed probability, decide to adopt (or not to adopt) a new practice or product that is introduced. This innovation is supposedly introduced at one point in time at one location, and diffuses throughout the population via a chain reaction: the first adopter introduces it to two others; each member of this pair introduces it to two more; et cetera. Adoption would proceed exponentially were it not for the limited size of the population. Eventually, this limit causes the rate of increase to decline, until additional adoptions cease.

Pictorially, the adoption process can be presented in two ways. First, a histogram can be drawn by plotting the number of those adopting an innovation against the year of adoption. The resulting graph is referred to as the "life cycle" of the innovation, and typically starts at zero, rises to a peak, and then declines once more to zero. Using modelling techniques, the observed data can be described by a smooth curve with known parameters (Figure 1). Alternatively, the cumulative number of adopters can be plotted against time, forming an S-shaped curve which can also be modelled.

Critics of mathematical diffusion models have questioned the validity of the assumptions that the models require. First, the critics note, rarely is a population of humans or of organizations homogeneous; each member, they argue is unique and it is unlikely that each would have the <u>same</u> likelihood of adopting an innovation, given exposure to it. Second, they maintain that the assumption of an unchanging environment or, equivalently, that adoption occurs independently of context, is implausible. Finally, they question the very concept of adoption. What is it? Can an innovation be "adopted" without being "implemented?" If so, does data on the adoption of innovations represent anything more that a shadow of reality?

Accepting these criticisms (who really can argue with them?) need not invalidate the use of mathematical models of the adoption process, but does require that one's research designs include compensating features. For example, restricting studies to relatively homogeneous sub-populations, or incorporating important characteristics of the population into the design, is an appropriate way to counter the first criticism. Limiting the time period studied is one method of addressing the third criticism. Given control over the variability within the population and the extent of contextual changes makes the assumption of a fixed probability of adoption more reasonable. Finally, a careful choice of the innovations to be studied can reduce the problem created by the failure of some adopters to fully implement an innovation. In particular, for some innovations adoption is synonymous with implementation. Additional building insulation, a popular conservation measure in some areas, is a good example: its installation guarantees its use, since in use it is static and no human attention is required for it to be effective.

Griliches' work, though completed almost a quarter century ago, deals with the problems raised by critics very effectively. He used the rate of adoption (as measured by the slope of the logarithmic transform of the S-shaped graph of the cumulative number of adopters) as the independent variable, and factors such as the average farm size, date of introduction, "Corn Beltiness," and the average difference in yield between regular corn and hybrid corn as independent variables. He used farms grouped by state and corn reporting district as sub-populations in order to control variation in both the characteristics of adopters and the span of time studied, since the adoption process began later in some states and growing districts than others.

Griliches' work appears to have to important limitations. First, to apply his findings, which apply to the aggregate level, to the level of the individual farmer requires one to make an "ecological" inference that may or may not be valid. Second, his decision to discard data on the first and last five percent of those adopting seems unsatisfactory if -- as is the case with much recent research -- one is interested in projecting future adoptions on the basis of very early data on the numbers of adoptions (Lawton and McLean 1981). The design and method of modelling used in the present study addresses both of these issues.

2.0 THE PROBLEM

Those concerned with policy at the provincial, state, or federal levels face problems not unlike the seed companies studied by Griliches. One of government's major "products" is policies that are meant to affect semi-autonomous subordinate units -- school systems, municipalities, and other such public bodies. In some cases, these policies are meant to encourage a practice, and in other cases to discourage one. It follows logically, that the type of analysis carried out by Griliches is applicable to the field of policy evaluation in order to determine factors that appear to affect the rate at which practices are adopted or discontinued. Of course, one may not be dealing with economic markets, as was Griliches, so the driving force behind adoption may be different; still, whether one adopts an innovation for profit, to avoid sanction, or to obtain some other "value" does not seem to be critical to the modelling process, though it is critical to understanding the process in substantive terms. Further, given the current economic environment in which the demand for efficiency in public agencies seems strong, it may well be that a desire to save money motivates those in public agencies to adopt innovations that reduce costs or to seek additional funds by adopting practices which bring special grants, such as the stimulation grants paid by the province of Ontario to school systems offering French language programs.

Though the reaction of public agencies to specific policies is of particular interest, it is clear too that agencies can and do adopt new practices without the encouragement or intervention of senior levels. Also, some provincial or state governments may adopt a policy to support or mandate a given practice while others do not. Hence, a comparison of the patterns of diffusion of an innovation in one jurisdiction with that in another may involve the study of "enhanced diffusion" in one and "natural diffusion" in the other. In practice, this situation may prove to be the most common if one is studying current trends, rather than historical data as was the case with Griliches. (Indeed, one can consider the adoption of a given policy by a senior level of government as a problem in itself, as did Hamblin, Jacobsen and Miller (1973) with the diffusion of compulsory schooling laws.)

The present study is an exploratory attempt to describe the diffusion patterns of a number of educational innovations among secondary schools in Canada, and to account for variation in these patterns. The approach to the problem taken here involves three steps: (1) collection of data on the diffusion of several innovations; (2) estimation of several characteristics of the life cycles of these innovations; and (3) explanation of variation in the statistics estimated in the step two.

3.0 SELECTION OF INNOVATIONS

The choice of innovations to study was difficult to make. Secondary education in Canada has experienced massive changes in the past 20 years and, with declining enrolments, will experience further rapid change for at least the next 5 to 10 years. Hence, any list of innovations must necessarily be somewhat arbitrary. Two criteria were used in selecting an innovation for study: (1) it had to be one for which adoption was, in effect, synonymous with implementation; (2) it had to be a practice that was, in my opinion, related to an important public issue.

The final selection of practices investigated in the study included (1) alternative modes of scheduling classes, (2) the addition of programs or courses to serve slow and gifted learners, and (3) steps undertaken to conserve energy. The first of these is an innovation in the <u>program organization</u> of education; the second an innovation in the <u>program content</u> of education; and the third represented an innovation in the <u>physical environment</u> of education. All of these innovations apply at the school level, though for any one of them the initial decision to adopt the practice may have occurred at a more senior level.

There are many other innovations in the organization, content, and physical enrvironment of education that might have been considered. These three, to me, appeared to have special importance. The greater flexibility in educational programs offered new time schedules is indicative of the general rejection of traditional rigidities within the structure of secondary school education in Canada. Along with the adoption of a "credit" or "unit" system of measuring educational progress, new time schedules represent a move away from a system of education that identified students on the basis of time spent in schools to one based on competencies mastered. To be sure, it is a small step, but even the minor flexibility offered by semestered courses that allow students to enter or leave school at mid-year is important when viewed in context. What is more, time schedules are an innovation for which adoption is <u>de facto</u> implementation.

Of the many innovations in the content of education the broadening of the educational mandate of secondary schools to include programs for those other than the university bound is perhaps the single most important innovation, socially speaking. Complementing programs for weaker students, and partly in reaction to the special treatment these students have received, are those for gifted students. Both of these innovations are somewhat "softer" than are revisions in time schedules, since there is no uniform standard for assessing levels of programs. (There is, of course, a universal standard for measuring time.)

The increasing size and complexity of secondary school buildings probably consitute the major innovation affecting the physical environment of education over the past two decades. Yet, the energy crisis brought on by the oil embargo of 1973 and the subsequent increase in energy prices, led to the choice of energy conservation measures as the set of innovations in physical environment to be studied.

4.0 DATA COLLECTION

Data of the sort needed to trace the process of adoption of innovations are not generally available, so it was necessary to conduct a mail survey of all schools in the target population, which consisted of all anglophone secondary schools (enrolling students in any or all of grades 10, 11, 12, and 13) in Canada's ten provinces. Because in some provinces middle (grades 7 or 8) and junior high schools (grades 7, 8 and 9) are classified as secondary institutions, a number of such schools were also included in the survey, though omitted from the analysis. A separate study of francophone schools is also being conducted.

Questionnaires were first mailed to principals of schools in mid-August, 1979. A brief annotated bibliography on scheduling practices was included with each questionnaire in the hope that this gift would stimulate respondents to return their questionnaires promptly. Subsequently, postcard reminders were mailed to non-respondents, first in mid-September and again in early October. Because a return of at least 70 percent was desired for each province, a second copy of the questionnaire was sent to schools in provinces in which the rate of return fell short of this goal even after two reminders.

Of the 1573 questionnaires originally mailed, a total of 1093 were ultimately returned, for an overall response rate of 69.5 percent. The rate exceeded 55 percent in all provinces.

5.0 THE AUTOCATALYTIC MODEL

The model of the diffusion process used in this study is based on the mathematical equations used to describe what in chemistry is referred to an autocatalytic reaction, which is a reaction in which the molecules of a substance formed as the reaction proceeds act as a catalyst to hasten the formation of additional molecules. The process is analagous to that suggested by Rogers' (1962) interaction effect -- the influence one adopter has on others who have not yet adopted a new idea, practice or product.

One useful idea this particular model has that is not present in other models of the diffusion process is that of a "seed." In an autocatalytic reaction, the process can be started by introducing a small amount of the compound that will be form. This amount "seeds" the reaction, and the larger the seed, the sooner the reaction will be completed. In the case of the diffusion of an innovation, the seed might be a demonstration project, publicity materials, or the advice provided by outside consultants. In the equations for the model, the seed is denoted by n.

The key element of the model is the rate constant that reflects the likelihood of an individual's deciding to adopt an innovation on contact with a previous adopter. In chemistry, rate constants are determined experimentally by measuring the rapidity with which two chemicals react. In the case of diffusion of innovations, rate constants are estimated from the history of a particular innovation's diffusion.

Two other components of the model are the number of first year adopters, s, and the total number of individuals who finally adopt. In fact, only three of the four parameters listed are needed to determine the adoption equation, but it is useful to consider each one for conceptual reasons. In addition, two other statistics can be computed, t_m and s_m, which are the year in which the maximum number of adoptions occur and the number of adoptions in that year.

The life cycle of an innovation, which is defined to be the rate of adoption by potential adopters as a function of time, is given by the equation

$$s(t) = p(N + n)Q(t)/[1 + Q(t)]^2$$

where n is given by

$$n = Nse^{-p} /[N(1 - e^{-p}) - s]$$

and $Q(t) = (N/n)e^{-pt}$, with t being time.

In practice, n, s, p, and N are estimated using a computer program, MODEL.FOR (Lawton and Lawton, 1979). Data for innovations whose life cycle is more than half completed are easiest to analyse. Then, one needs only enter the year in which adoption commenced and the number of adoptions that had occurred in each year. For "younger" innovations, it is often necessary to guess in advance the total number who are likely to adopt, the size of the seed, or the rate constant. For such analyses to be reasonable, one needs to know the history of similar innovations, so that realistic values of these parameters can be selected.

6.0 FINDINGS

The findings of the survey are presented in three sections paralleling the three types of innovations. In each case, diffusion of the practice at the national and provincial levels is discussed first, followed by a report and then analysis of the various rates of diffusion.

6.1 Scheduling Practices

Eight types of scheduling practices were identified in the questionnaire. They were as follows: Traditional, Modified Traditional, Full-credit Semester, Half-credit Semester, Mixed Full-credit and Half-credit Semester, Trimester, Quarter System, and Immersion.

This classification scheme is quite standard in the literature (Davis, 1977) except for its use of the "modified traditional" category. This latter scheduling practice typically involves use of a two day cycle for some or all courses, so that each course can be scheduled for approximately 70 to 80 minute classes rather than the traditional 35 to 40 minute classes. Under it a school is able to obtain one of the major benefits attributed to semestering -- long periods of instruction -- without introducing its second major feature -- mid-year re-entry for drop-outs and mid-year graduation for others.

In treating the data on scheduling, it was assumed that a school had one and only one time scheduling system at a time. In fact, some had more than one: a number of schools reported having different forms of scheduling in different grades. Most commonly, such schools reported traditional shedules in grades up to 9 or 10, and an alternative form in higher grades. In such cases, the response applicable for higher grades was used in the analysis.

The mode of analyzing the data for scheduling changes involved the estimation of certain parameters for the "life cycle" of the innovation. Key parameters include the number of years that pass between the introduction of an innovation and the peak year of its adoption, the total number of adopters, and, most important, the rate of adoption.

Data for initial scheduling changes were combined on an annual basis to yield the total number of schools changing from traditional schedules (or no schedule in the case of new schools) to one of the other forms of scheduling. The life cycle of scheduling innovations commenced shortly before 1966 on a national basis, crested in the early 1970's, and is now tapering off. Overall, 58 percent of all schools responding reported having adopted one of the new forms of scheduling; this percentage can be taken as a measure of the "penetration" of the innovations, to use a term employed by economists who speak of the market penetration achieved by new products.

The overall pace of adoption can be best assessed by fitting a theoretical curve to the observed data, as has been done in Figure 1. As in fitting a regression line to linear data, fitting this curve removes irregularities and allows one to see the underlying trend more clearly. In calculating the equation for the curve, estimates of key parameters are produced. For the adoption of new time scheduling practices across Canada, they are: the number of years from introduction to peak adoption (6 years); the number adopting in the peak year (65.5); the total population of adopters (571 of the 981 respondents, or 58 percent); and the rate of adoption (0.42). Since the bumps in the observed data have been smoothed, these numbers do not coincide perfectly with the observed values (e.g., 65.5 adopters in the peak year is estimated, though the actual number was 80).

The rate of adoption, denoted by p, is the most important number derived from the data. Mathematically, it is proportional to (though not equal to) the probability of a school having adopted a form of innovative scheduling given that they have considered the possibility. It is rather like the chance of catching a cold given that your spouse has one--sometimes it happens and sometimes it doesn't. If we all kept records of our encounters of this sort, and epidemiologists collected and analyzed them, then they could estimate what this probability is in the population at large. In effect, this is what has been done in this and other studies of the adoption of innovations. Based upon these other studies, it is possible to state that a high value of p ranges from 0.7 to 1.5, and that innovations (or diseases or fads) with such high values spread through a population very rapidly. In contrast, innovations with low values of 0.2 or 0.3 spread very slowly (Lawton and Lawton, 1979). The value of p observed for innovative scheduling practices in Canada is 0.42 and is toward the low end of the moderate range.

The timing of the introduction of new scheduling practices varied considerably from province to province (Table 1). Alberta, British Columbia and Saskatchewan led in the introduction of these practices, with a few of their schools having introduced them before 1966. A few schools in several Atlantic provinces reported experimenting with new time schedules in 1966, but adoption proceeded apace primarily in Manitoba and Ontario, and, to a lesser extent, Quebec, after 1967. Among the Atlantic provinces, only

Prince Edward Island experienced the conversion of a large percentage of its schools to new types of schedules, and this mostly after 1975.

The penetration of new forms of scheduling differs greatly among the provinces. Eighty-eight percent of Alberta's schools report having one of the more innovative forms of scheduling, while only 18 percent of Newfoundland's schools report such schedules. The geographic relationship implied by this comparison holds fairly consistently, with the highest degree of penetration in the West and the lowest in the East, with Ontario and Quebec being near the national average.

A comparison of rates of adoption shows a similar relationship, although it is not as systematic. The highest rate of adoption was in Saskatchewan ($p = 0.98$) where adoption of semestering was fostered by the Department of Education, first with 10 demonstration projects and later by advising that semestering be adopted (King, 1975). The rates of adoption in Alberta and Manitoba, while still high, were less than those in Saskatchewan; that in British Columbia was only slightly higher than that in Ontario; and those in Quebec, New Brunswick, and P.E.I. were similar to the nation-wide rate. In both Ontario and P.E.I, significant numbers of adoptions occurred only after changes in provincial regulations. In Ontario, introduction of the credit system in 1970 was accompanied by a loosening of the regulations controlling school time scheduling that, in previous years, had required Ministry approval of innovative schedules. In P.E.I., the provincial wide consolidation of schools in 1975 coincided with the adoption of new scheduling practices.

Clearly, legislative and regulatory actions of provinces have had a strong effect or the diffusion of new time scheduling practices. In some cases (e.g., Ontario), restrictive regulations initially slowed what appears to have been the "natural" diffusion of an innovative practice that began in Alberta. In contrast, supportive provincial actions adopted quite early in the life cycle of the innovation had the effect of enhancing diffusion in Saskatchewan. In the Atlantic provinces (except for P.E.I.), there never appears to have developed a climate of opinion supportive of innovative scheduling. After a series of experimental adoptions, the innovation died. It would appear that, had provincial ministries supported innovative time schedules in the Atlantic provinces, diffusion would have occurred, but that without action at that level, the natural forces of diffusion were insufficient. Conversely, it appears that had the ministries in Western provinces opposed this innovation, diffusion would have been slowed or stopped. As Stapleton (1974) has shown, the two levels do not act independently. In fact, pressure from the field often causes those in the ministry to react. If the action is positive, then diffusion is enhanced; if it is negative, it is slowed. Where large capital investments and/or large scale cooperation are needed, it may even be that ministerial inaction will doom an innovation (Lawton, 1980a).

6.2 Special Programs

Paralleling the introduction of new scheduling practices in Canadian secondary schools has been the introduction of a broader range of courses and programs, some of which were designed to meet the educational needs of students for whom learning is either particularly difficult or particularly easy. In order to trace the introduction of these new courses, respondents were asked to indicate the years during which courses or programs of the following types were offered: Level 1, special education for those with severe to moderate handicaps; Level 2, programs for those with mild retardation; Level 3, remedial courses or programs; Level 4, courses or programs serving the majority of students; Level 5, courses or programs for students who would normally be expected to continue to university; Level 6, courses for the gifted; In-school advanced placement; and Advanced college placement.

Virtually all of those responding indicated that throughout the period from 1966 to 1978, their secondary school offered level 4 (general) and level 5 (academic) courses and/or programs. Also, the expected increase in courses at the lower and upper levels was confirmed. In 1966, 716 of the schools in the sample were open. Of these, 87 percent had offered courses at level 5, 86 percent at level 4, 30 percent at level 3, 12 percent at level 2, 8 percent at level 6, and 2 percent at level 1; also, 4 percent practiced in-school advanced placement and 1 percent advanced college placement. For 1978, the 981 respondents reported the following distribution of offerings: 94 percent, level 4; 90 percent, level 5; 77 percent, level 3; 33 percent, lvel 2; 30 percent, level 6; 16 percent in-school advanced placement; 8 percent, level 1; and 3 percent advanced college placement.

The greatest increase in course offerings, in terms of the percentage of all schools offering courses at a given level, was at level 3 (remedial). Yet, in terms of relative gain, there was a three-fold increase in the number of schools offering level 6 (gifted) courses, and almost a four-fold increase in the number practising in-school advanced placement. A similarly large increase occurred in the number of schools offering level 1 courses for the trainable mentally retarded. It should be noted, in this regard, that a number of respondents commented that in their systems all level 1 students were enrolled in a single school. Hence, such special courses are more widely available than the statistics may indicate.

Taken together, the preceding figures imply that there has been a tremendous broadening in the levels of courses and programs offered in the typical Canadian secondary school. There is far greater emphasis on the needs of the slower student today than there was fifteen years ago, and a substantially greater emphasis on the needs of the most capable students.

While it is well to document the broadening of the spectrum of courses offered in secondary schools, the major goal of this study was the analysis of patterns of diffusion. To simplify analysis, data for the three lower levels of course offerings, levels 1, 2, and 3, were combined, as were those for level 6 offerings and the two forms of advanced placement. The resulting indices range from 0 to 3: 0 if no courses of the type in question had been added in a given year, and 3 if all three types had been adopted. The national averages for these indices were 1.19 for the lower level programs, and 0.49 for the upper level programs, implying the average school had adopted 1 lower level program, and that only half of all schools had adopted a single upper level program. To obtain an index of penetration, these values can be divided by 3. Doing so yields a penetration of 0.40 for lower level programs, and 0.16 for upper level programs.

Using the index of penetration, the changes in the levels of programs in Canadian secondary schools over the past fifteen years is evident. For lower level offerings, it increased from 0.15 in 1966 to 0.40 in 1978; for upper level offerings it rose from 0.04 to 0.16.

Values of the indices of penetration for different levels of offerings for all provinces are given in Table 2, together with estimates of rates of adoption and other characteristics associated with an innovation's life cycle. There are four findings evident in this table.

First, compared with the adoption of new forms of scheduling, the adoption of programs and courses for slower students was far more uniform across the country; the degree of penetration ranged from only 0.31 in Alberta to 0.51 in Quebec.

Second, the rates of adoption of both lower level and upper level offerings were very low compaered to the rates observed for new scheduling practices. The average of the intra-provincial rates for the former two were 0.29 and 0.36 respectively, whereas the average value for the latter was 0.54.

Third, the average rate of adoption for upper level offerings was greater than that for lower level offerings, even though the penetration of the former was lower (averaging 0.16) than that of the latter (averaging 0.43).

Finally, it is notable that there appears to have been a tendency for provinces in which a high percentage of schools adopted new forms of scheduling to have experienced a relatively low degree of penetration for special program offerings. The Prairie provinces, which ranked 1, 2, and 4 in the adoption of new scheduling practices, ranked 8.5, 8.5, and 10 in the adoption of offerings for lower level students, and 7, 9, and 10 in the adoption of offerings for upper level students. In contrast, the Atlantic provinces, which ranked 6, 8, 9, and 10 in the percentage of schools adopting new scheduling practices, ranked 3, 4, 5, and 8,5 in the adoption of lower level offerings and 1, 4, 5.5, and 5.5 in the adoption of upper level offerings. Put another way, the Pearson product-moment correlation coefficient between the percentage of schools adopting a new form of scheduling in a province and the degree of penetration of lower level offerings was -0.45, while that between the former variable and the degree of penetration of upper level offerings was -0.29. In both cases, the major exception to the overall relationship was British Columbia, which was a leader in both the adoption of new scheduling practices and courses for students with special needs.

The patterns of diffusion for new courses serving either end of the educational spectrum suggest a slow, yet persistance, change has taken place in the definition of secondary education. This change began before the period for which data were collected and will continue into the future. The high school offering a classical curriculum has replaced by into an institution serving mass society. However, this metamorphosis has occurred within the different value contexts. In answer to the question, How should education meet the needs of students of different ability?, two philosphical or ideological positions are held. One favors common secondary schools in which the needs of students are met via the individualization of programs; the other advocates structural divisions within schools that stratify students according to their gifts and skills. This conflict in values may account for the differing popularity of special programs in the various provinces, and the inverse relationship between the adoption of such programs and new time schedules.

Stated simply, the more conservative, hierarchical, and denominational societies found in Eastern Canadian provinces appear more likely to reflect the stratification of their societies in their philosophies of education and in their schools; hence the greater popularity of special courses and programs in these provinces. In contrast, the Western provinces, and especially the Prairie provinces, are more liberal, egalitarian, and secular societies, and this fact is reflected in their philosophies and schools in the form of common schools and common courses in which special assistance is provided on an individual basis. An analagous situation obtains with regard to the education of the mentally handicapped. The "conservative" solution is the operation of separate schools and classes, while the "liberal" position is represented by mainstreaming. Though the data were not sufficiently precise to test this hypothesis, if this analysis is correct, then one would expect the adoption of mainstreaming to follow the pattern of new time scheduling, another innovation which broke down educational barriers, rather than that of the adoption of special programs.

6.3 Energy Conservation

Measures undertaken in schools to conserve energy formed the final set of innovations about which infoRmation was sought in the suRvey. Respondents were asked to indicate which of five steps had been taken to conserve energy in their schools, the year these steps were taken, and the sources of initiative for these steps. The five steps were (1) energy assessment of school plant to determine where consumption could be reduced, (2) additional roof insulation, (3) additional window insulation (e.g., new storm windows or replacement of windows with double-paned windows), (4) new or modified heating system to increase efficiency (e.g., change in fuels or install automated controls to lower temperatures at night), and (5) reduced or more efficient lighting. They were also asked to describe any other steps that had been taken. In every case, it was assumed that the adoption process commenced in 1973, the year of the first oil embargo.

The penetration (i.e., the percentage of all schools adopting) of each of the conservation measures varied considerably (Table 3). Only 5 percent of all secondary schools reported having added roof insulation, 14 percent window insulation, and 23 percent modified heating systems. Yet, 44 percent reported having conducted formal energy assessments, and 49 percent reported having reduced lighting in order to save energy.

Among the regions, differences also prevail. Ontario is the apparent leader in terms of the percentage of schools that have conducted energy assessments, followed by Quebec, the Atlantic provinces, British Columbia, and the Prairies. For the adoption of modified heating systems, this same ordering among the regions prevails, and it changes only slightly in the case of reduced lighting, with British Columbia lagging behind the Prairies and Quebec behind the Atlantic provinces. For the addition of insulation, however, the pattern is quite different. Though relatively rare throughout the country in comparison to the other conservation measures, addition of both roof and window insulation was reported by a significant percentage of schools in the Atlantic provinces. It was less common in the Prairies and Ontario, and rare in British Columbia and Quebec.

All of the rates of adoption for energy conservation measures are relatively high when compared with those for the various program innovations. Only the rates observed for the spread of new systems of time scheduling in Alberta and Saskatchewan are comparable. On a national basis, the rate of adoption for reduced lighting is highest at 1.34, followed by that for conducting energy assessments (1.27), modifying heating systems (0.82), and adding window insulation (0.73) or roof insulation (0.60; see Table 3).

Variation in rates of adoption among the various regions is evident, though trends are difficult to identify precisely. Broadly speaking, rates of adoption are highest in Eastern Canada, and lowest in Western Canada -- a difference reflecting their relative "energy" wealth. The highest single rate was that for reduction in lighting in Atlantic Canada, a region where most electricity is generated from imported oil.

Adoption of most of the conservation measures is obviously just beginning. Using the autocatalytic model it is possible to project future adoptions given the current cost of energy. Such projections are reltively simple extrapolations. However, it is also possible to make alternative projections based upon different assumptions regarding future prices. A higher level of prices would improve the cost-benefit ratio of all conservation measures, and the population of future adopters would increase. By treating previous adoptions as a seed that stimlates further adoptions, a striking increase in the number of future adopters is projected. For example, under current conditions, the total number of schools likely to add window insulation is 191, or 20 percent of all respondents. If, in 1981, the real price of energy were to increase an amount equal to that which has occurred since 1973, then the projected number of adopters is 377, or 39 percent of the

958 respondents (Lawton, 1980b).

The preceding discussion assumes that those in schools and school systems make decisions in economically rational ways. The evidence seems to support this view, if one considers the different degrees of penetration of the various practices. A review of the literature on energy conservation indicated that, given the current cost of energy, only reduced lighting and, perhaps, improved heating and ventilation systems are cost effective. In most cases, additional insulation, especially roof insulation, is not warranted given the difficulty of adding insulation in most schools and the remaining life of school buildings. Of course, as the cost of both energy and the construction of new buildings increases, this conclusion may no longer be valid. It appears, in short, that the observed degree of penetration of the five conservation measures closely parallels their ordering in terms of the current ratio of their costs to benefits.

7.0 SUMMARY AND CONCLUSION

This study investigated the diffusion of three types of innovations in secondary schools in Canada, innovations in program organization (time scheduling), in program content (courses for special students), and in physical environment (conservation measures). Analysis focussed on the rate of innovation as estimated by a mathematical model of the adoption process, the percentage of schools adopting, and explanations for variations in these two statistics.

Different explanations were offered to account for the patterns of diffusion for each class of innovation. First, the role of regulations and legistlation in the diffusion of time schedules appeared substantial. Natural diffusion was delayed in some provinces, and enhanced in others. Second, the values of provincial societies seemed to account for the variation in the diffusion patterns of offering for students with special needs. Schools in more conservative provinces favoured a form of streaming, while those in more liberal provinces apparently met the needs of the students within common classes. However, the intermixture of program content and structure, in this case, makes definitive statements difficult. Third, economic factors clearly accounted for regional differences in rates of adoption and degrees of penetration of energy conservation measures; both were related to the cost effectiveness of a given practice.

Although regulations, money, and cultural values have been presented as separate explanations, the three are interlinked. The economic growth of Western Canadian provinces encourages liberalization, and wealth exists to fund experimental programs. A populist tradition there also encourages grass roots diffusion of innovations, and where regulations are made, they foster their development. The economic difficulties of Eastern Canada foster rapid innovation in the service of conserving energy, but tend to reinforce traditional conservatism and its hierarchical view of society. The democratization of secondary education that has occurred an a global scale in the past century has occurred in Eastern Canada, but takes on a form in which the stratification of its provincial societies is reflected. The role of their ministries of education appears one of slowing, rather than fostering, innovation. Without strong pressure from below to act, innovation may be stillborn, its life cycle ending before it begins. Yet, when provincial action is taken, it is likely to be done on a massive scale, as with the reorganization of Prince Edward Island's entire system of education in 1975.

This analysis, though primarily heuristic rather than statistical, requires further validation. It is necessary to relate specific policies and values more clearly to decisions to adopt. Economic benefits need to be measured more precisely, whether they occur as money saved by conserving energy or money earned by adopting programs for which special grants are available.

This study has provided strong evidence that new mathematical techniques for modelling the diffusion process can be used as an effective tool in assessing the effects on junior levels of government of specific policies adopted by senior levels of government. The promise of the method is that, when combined with a fair appraisal of the natural forces of innovation rooted in the values of the communities, provinces, and regions, it will facilitate the development of policies whose objectives can be achieved without unnecessary intervention or expenditure by senior levels of government.

REFERENCES

1. F. M. Bass, "A New Product Growth Model for Consumer Durables," Management Science, 15, 5 (1969): 215-227.

2. J. E. Davis, J. A. Ross, D. J. Ducharme, W. French, The Impact of Semestering on Selected Secondary Schools in Ontario (Toronto: Ministry of Education, 1977).

3. R. L. Hamblin, R. B. Jacobsen, and J. L. L. Miller, A Mathematical Theory of Social Change (New York: John Wiley, 1973)

4. A.J.C.King, J.L.Clements, J.G.Enns, J. W. Lockerbie, and W. K. Warren, Semestering the Secondary (Toronto: The Ontario Institute for Studies in Education, 1975).

5. Z. Griliches,"Hybrid Corn: An Exploration in the Economics of Technological Change," Econometrica 25, 4 (1957): 501-522.

6. S. B. Lawton and W. H. Lawton, "An Autocatalytic Model for the Diffusion of Educational Innovations," Educational Administration Quarterly 15 (1979): 19-46.

7. S. B. Lawton, "The Diffusion of Automation in the Technical and Public Services Areas of Libraries in Post-Secondary Educational Institutions in Canada" (Toronto: The Ontario Institute of Studies in Education, 1980a), unpublished paper.

8. S. B. Lawton, "Innovative Scheduling, Program, and Conservation Practices in Canadian Secondary Schools," (Toronto: The Ontario Institute for Studies in Education, 1980b), unpublished paper.

9. S. B. Lawton and R. S. McLean, "Use of Computers for Instructional Purposes in Ontario Schools" (Toronto: The Ontario Institute for Studies in Education, 1981), unpublished paper.

10. E. Mansfield, The Economics of Technological Change (New York: Norton, 1968).

11. F. Martin, N. Swan, I. Banks, G. Barker, and R. Beaudry, The Interregional Diffusion of Innovations in Canada (Hull, Quebec: Minister of Supply and Services Canada, 1979).

12. E. M. Rogers, Diffusion of Innovations (New York: Free Press, 1962)

13. J. Stapleton, "The Politics of Educational Innovation: A Case Study of the Credit System in Ontario" (Ph.D. dissertation, University of Toronto, 1975).

14. M. J. Tebbutt, "The Growth and Eventual Impact of Curriculum Development Projects in Science and Mathematics," Curriculum Studies 10, 1 (1978): 61-73.

15. M. J. Tebbutt and M. A. Atherton, "A 'Reaction Kinetics' Model for the Growth of Curriculum Projects," Curriculum Studies 11, 2 (1979): 159-166.

Table 1

Life Cycle of Adoption of New Time Schedules in Anglophone Secondary Schools by Province

Year	Province										
	Nfld.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.	Canada
Pre 1966						1		3	12	11	27
1966			1	1				4	6	2	14
1967				1	2	7	2	2	5	4	23
1968	1		2		1	8	1	5	16	10	44
1969	1	1		1	3	14	1	8	11	17	57
1970			3	1	4	27	3	11	13	18	80
1971	3			1		22	6	8	5	15	60
1972				1	3	25	10		3	8	50
1973	1		1		1	34	7	1	4	9	58
1974						32	5		1	9	47
1975	1	1	1		3	26				5	37
1976	2	3			1	20	3	1		5	35
1977			1	1	1	16	1		1	4	25
1978	1		1			11	1	1	2	2	19
Total Adopters	10	5	10	7	19	243	40	44	79	119	576
Sample Size	48	10	57	34	46	438	54	54	90	150	981
Percent Adopt.	20.8	50.0	17.5	20.6	41.3	55.5	74.1	81.5	87.8	79.3	58.7
Estimates of Life Cycle Parameters											
Years to Peak: Y_m	7.6	12.4	3.1	2.8	2.3	7.7	6.7	3.9	3.4	5.2	6.0
Max. Adopt.: s_m	1.0	1.0	1.0	0.9	2.2	32.4	8.2	10.1	13.0	15.3	65.5
Total Adopt.: N	11	Fixed	Fixed	Fixed	20	259	39	40	64	107	571
Rate of Adopt.: p	.34	.41	.27	.38	.38	.49	.84	.98	.75	.54	.42

Table 2

Estimates of Parameters for the Life Cycles of Offerings for Remedial/Handicapped and for Gifted Students

Parameters Estimated	Province										Canada (n=981)
	Nfld. (n=48)	P.E.I. (10)	N.S. (57)	N.B. (34)	Que.(E) (46)	Ont. (438)	Man. (54)	Sask. (54)	Alta. (90)	B.C. (150)	
			Group 1: Remedial/Handicapped								
Total Adoptions:	62	10	75	40	70	451	53	54	83	214	1165
Penetration to date:	.43	.33	.44	.39	.51	.34	.33	.33	.31	.48	.40
Years to Peak: y_m	8.9	-	6.0	-	6.4	14.3	4.6	8.2	11.7	10.7	12.2
Max. annual pen: 5_m	.05	-	.03	-	.05	.03	.02	.02	.03	.04	.03
Total Penetration:	.43	-	.44	-	.43	.67	.24	.33	.45	.53	.59
Rate of Adoption: p	.44	-	.23	-	.49	.16	.28	.24	.25	.19	.19
			Group 2: Gifted								
Total Adoptions:	9	9	33	19	26	225	23	11	12	39	480
Penetration to date:	.06	.30	.19	.19	.19	.17	.14	.07	.04	.20	.16
Years to Peak: y_m	2.0	-0.0	5.5	10.3	6.3	8.0	6.5	13.4	3.4	12.9	14.1
Max. annual pen.: 5_m	.01	.03	.02	.02	.02	.02	.01	.01	.003	.04	.02
Total Penetration:	.06	.30	.13	.20	.17	.17	.11	.11	.04	.50	.33
Rate of Adoption: p	.30	.20	.54	.35	.54	.38	.36	.17	.23	.18	.18

Table 3

Estimate of the Penetration and Rate of Adoption of Conservation Measures by Region

Measure	Region					
	Atlantic	Quebec (English)	Ontario	Prairies	B.C.	Canada
Energy Assessment						
Sample Size	146	45	411	195	144	941
Percent Adopt. to date	41	49	61	21	31	44
Rate: p	1.28	1.29	1.01	0.83	1.01	1.27
Roof Insulation						
Sample Size	148	46	423	196	145	958
Percent Adopt. to date	10	2	4	6	3	5
Rate: p	0.71	-	0.49	0.54	0.67	0.69
Window Insulation						
Sample Size	143	46	417	194	144	944
Percent Adopt. to date	18	4	15	16	8	14
Rate:p	0.59	-	1.20	0.53	0.61	0.73
Heating System						
Sample Size	145	45	410	192	141	933
Percent Adopt. to date	23	27	28	13	21	23
Rate: p	1.07	1.23	0.77	1.53	0.42	0.82
Lighting						
Sample Size	134	44	396	188	143	905
Percent Adopt. to date	48	41	76	30	5	49
Rate: p	1.51	1.10	1.43	0.96	0.87	1.34
All Measures						
Average Sample Size	144	45	411	193	143	936
Penetration % to date	28	24	36	17	14	27
Rate: p	1.08	1.16	1.29	0.88	0.97	0.97

Figure 1

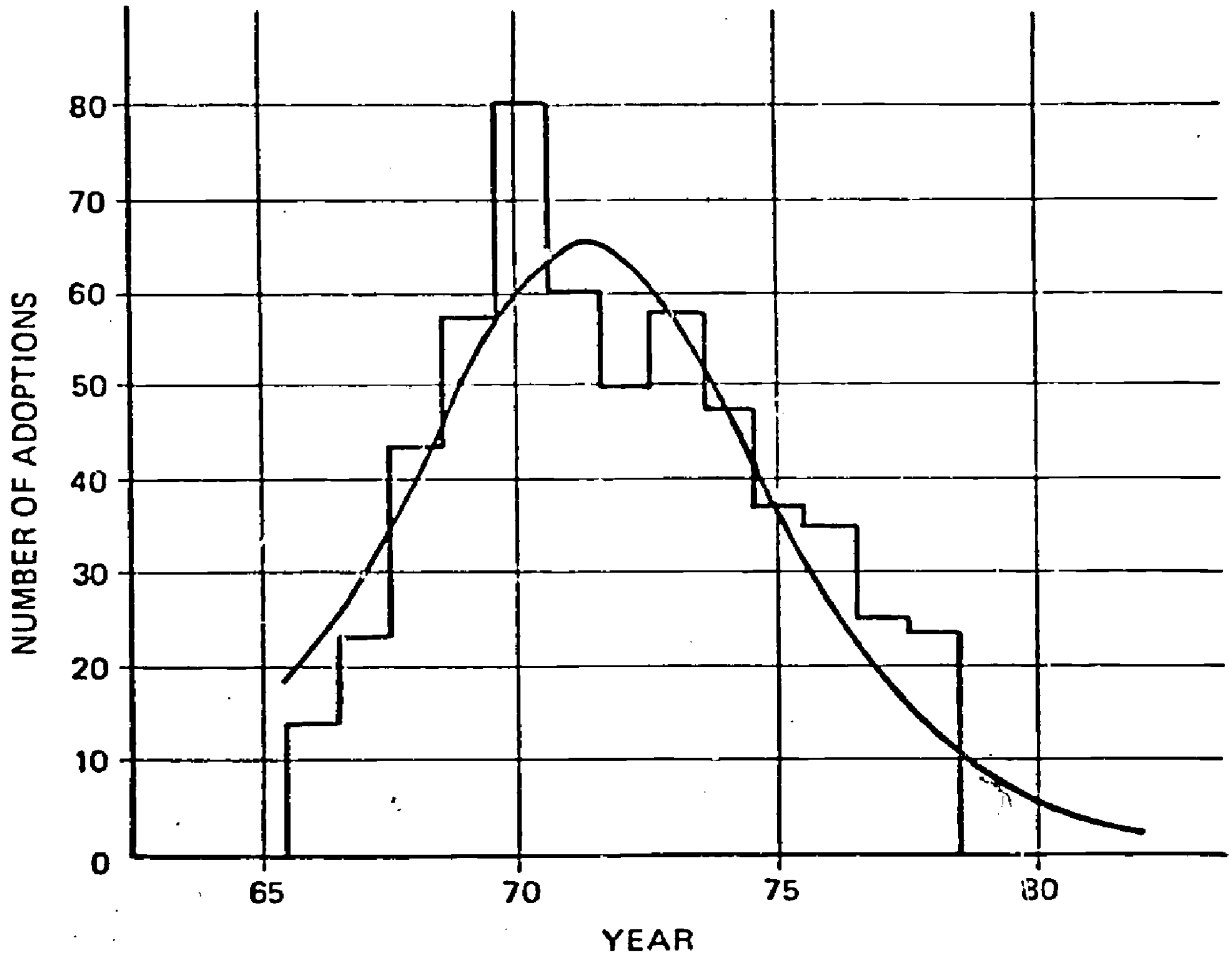

Figure 1. Actual and Estimated Number of Canadian Secondary Schools Adopting New Forms of Scheduling, 1966 - 1982