

to aid in explicating the theory and in testing policy alternatives.

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THE DYNAMICS OF EFFECTIVE AND INEFFECTIVE SCHOOLING:
A SYSTEM DYNAMICS POLICY STUDY

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The Problem

In large numbers of U.S. urban elementary schools, there is a multiplier effect which operates to reinforce high achievement for initially high-achievers, average achievement for initially average-achievers, and failure for initially low-achievers. This problem is aggravated by the fact that initial levels and perceptions of achievement are systematically related to social class. In part, poor children enter school with less readiness for reading. Evidence also suggests that, actual achievement aside, teachers tend to perceive lower-class children as low-achievers simply because they exhibit lower-class family, dress, and behavioral characteristics.

In contrast, there are a relatively small number of "lighthouse" schools spread throughout the country in which students, often minority and/or poor, achieve far better than home or SES variables would predict.

Research Objectives

Our work has two main purposes: (1) to develop a theoretical framework for understanding the essential dynamic differences between schools that are effective and ineffective for initially low-achieving students; and (2) to assess the relative effectiveness of, and the tradeoffs associated with, various policies for improving elementary schools for initially low-achievers. A system dynamics model - the Effective Schooling Model - has been formulated

The Dynamic Hypothesis

The most fundamental difference between schools which are effective and ineffective for initially low-achieving students is the way in which differing expectations for low-achieving students lead to different patterns of instruction. According to this hypothesis, appropriateness and intensity of instruction constitutes an institutional response to a perceived learning gap. The perceived learning gap is the difference between the expectations teachers and principal hold for students and their perceptions of how well students are actually achieving. In the model, as in the hypothesis, it is the perceived learning gap which exerts pressure on teachers and principal to accept professional responsibility for low-achieving students and to work institutionally to increase the appropriateness and intensity of instruction of low-achieving students.

The hypothesis suggests that in the ineffective school teacher and principal expectations for students regress toward actual achievement, a dynamic which has the effect in such a school of "writing off" initially low-achieving children from the very beginning as students who cannot keep up. It is this dynamic in ineffective schools which obviates any perceived learning gap and any institutional responsibility for improving instruction.

In contrast, the hypothesis argues, in effective schools the teachers and principals maintain their belief that all but clearly exceptional children can learn at grade level standards. In these schools, teachers and principal perceive a learning gap for low-achieving students, accept institutional responsibility for closing this gap, and work to do so by improving the appropriateness and intensity of instruction for low-achieving students.

Policy Questions

The policy options available for administrators at the school or district level cluster in four areas: (1) changes in the school and student population; (2) changes in the quantity of instruction; (3) changes in the quality of instruction; and (4) changes in the school climate. Population changes can occur through changing school size, the relative proportion of low- vs. average- and high- achievers, or the initial handicap of low achievers with head-start programs. The quantity of instruction for low achievers can be modified by changing class size, teacher emphasis patterns, the emphasis among content areas, and teacher expectations. Changes in quality are accomplished through staff development. School climate can be modified by classroom and school-wide efforts to improve behavior. The present stage of policy analysis assumes that desired policy interventions can be successfully implemented. In future analysis, the authors will incorporate organizational characteristics that often thwart implementation (e.g. limits on principal's skill and time, and staff resistance to change).

Major Model Elements

The model represents a school with a number of elements common to elementary schools in the U.S.. It portrays students entering the school in grade one, moving through grades one to six, and leaving at the end of grade six. This process is a continuous one over any time frame.

The major simplifying assumptions in the model operate to reduce variability. The first of these is that students are of only three kinds: initially high-, initially average-, and initially low-achievers. The only parametrized differences among students have to do with initial achievement. The model makes no other assumptions about input characteristics of students. The second simplifying assumption in the model relates to teachers. The model

characterizes the average teacher. It specifies no variation among teachers.

Thus, within the model, three groups of students move grade-by-grade through a six grade elementary school. Each group of students behaves at each grade level in its own way, consistent with its motivation to learn, and each group of students learns at each grade level at a rate determined by its motivation and the appropriateness and intensity of instruction for that group at that grade level. Student behavior in one group and at one grade level is also affected by student behavior in other groups and at other grade levels. It is also affected by faculty efforts to improve behavior. The appropriateness and intensity of instruction is affected by a variety of factors including teacher skills, time allocated to reading instruction, student behavior and motivation, etc. In essence, the model reproduces many of the interactive and circular effects of a complex set of variables which include student learning, motivation, achievement and behavior, teacher expectations and skills, principal expectations and skills, as well as decisions about time allocations on the part of teachers and the principal.

Preliminary Results

Preliminary analysis of the policy runs indicates, in accord with current research, that larger school size, larger class size, and a higher percentage of low achievers have detrimental effects on achievement, with greatest impact on the initially low-achievers. Interventions aimed at changing the quality and quantity of instruction seem to be effective in the long term only if they bring about changes in teacher expectations for low achievers. Otherwise, teachers return to their "old" patterns of behavior where high achievers improve and low achievers fail.

More detailed results will be reported in the full paper and at the technical session.

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The continued failure of most urban elementary schools to educate students effectively has been well documented (cf. Edmonds, 1979; Kozol, 1967; Silberman, 1970; Weber, 1971). There is persistent reference in the literature to a widening gap in reading achievement between poor and middle class children. The problem can be viewed, then, as a discrepancy between the actual patterns of reading achievement for initially low achieving students in urban elementary schools and a desired level of achievement for all students.

This problem can be described from the perspective of cohorts of students moving through an elementary school or of the school assessing patterns in reading achievement for successive cohorts over a period of years. From the cohort perspective, if students entering the first grade in a given year are divided into initially low-, average-, and high- achievers, based on indicators of reading readiness, the graph of cohort achievement in reading over the six years of elementary school would show a widening gap between the low and average achievers. From the school perspective, if one examined the reading achievement scores of six graders who were initially high-, average-, and low- achieving students, one would find that initially low achieving sixth graders maintain a pattern of achievement one to three years below the average achievers and the initially high achievers one to two years above the average achievers.

The existence of these reference behaviors is not well documented in the literature. There are two reasons for this. The first is the tendency on the part of school administrators to report average grade level achievement scores. The second reason for a lack of clear research evidence is the dearth of longitudinal studies. However, few deny that the problem exists. The debate has concerned the relative contributions of schooling, family background or socio-economic status (cf. Bridge, et al., 1979; Coleman, et al., 1966).

Current research suggests that (1) schools can affect patterns of achievement regardless of the initial level of the achievement, home and SES background variables (e.g., Averch, et al., 1974; Barr and Dreeben, 1977; Edmonds, 1979; Fowler, 1980; Rutter, et al., 1979); (2) that there exist schools today which are effective for initially low achieving students (Benjamin, 1980; Brundage, 1980; Phi Delta Kappa, 1980; Salganik, 1980; Weber, 1971); and (3) that the general characteristics of effective teaching and effective schooling are known (cf. Berliner, 1979; Bloom, 1976; Medley, 1979; Rosenshine, 1979; Dreeben & Thomas, 1980; Harnischfeger & Wiley, 1976; Thomas, 1977; Wiley, 1976).

The School Effectiveness Model is designed to address the following question: What mix of strategies available to administrators at the school or district level is most effective in closing the achievement gap for initially low achieving students? The policy options examined with the model cluster in four areas: (1) changes in the school's student population; (2) changes in the quantity, or intensity, of instruction delivered to initially low-achievers; (3) changes in the quality, or appropriateness, of instruction; and (4) changes in the school climate.

The present stage of policy analysis assumes that desired policy interventions can be successfully implemented. In future analysis, the authors will incorporate organizational characteristics that often thwart implementation (e.g. limits on principal time and skill, and staff resistance to change).

Dynamic Hypothesis

The problem behaviors suggest the existence of a multiplier effect in the ineffective school that operates to reinforce the initial achievement differences among entering students. We argue that the fundamental difference between schools which are effective and ineffective for initially low-achieving children lies in the relationship between Observed Achievement and the Appropriateness and Intensity of Instruction which the school delivers to different achievement groups. Based upon considerable research on "Direct Instruction," [2] it is assumed that in all schools, effective and ineffective, there is a direct causal relationship between the appropriateness and intensity of instruction and the rate at which children, especially poor children, learn to read (Benjamin, 1980; Medley, 1979; Rosenshine, 1979; Salganik, 1980). We hypothesize that effective schools provide instruction to low achieving students which is appropriate and more intense in order to bring their reading achievement up to grade level. In the ineffective school, instruction is most intense and appropriate for children whose achievement is already at grade level or above and increasingly less intense and appropriate for children who read further and further below grade level.

Thus, effective schools are characterized by negative feedback between observed achievement and appropriateness and intensity of instruction (where low achievers get more intense instruction) and ineffective schools are characterized by positive feedback (in which low achievers get less appropriate and intense instruction). We argue that it is differing expectations of teachers for low achieving students that determine different patterns of appropriateness and intensity of instruction in the effective and ineffective schools. This is our dynamic hypothesis.

This difference in expectations that teachers and principals have for students is found repeatedly in the literature (Benjamin, 1980; Brophy & Good, 1970; Brookover et al., 1979; Edmonds, 1979; Phi Delta Kappa, 1980;

[2] Direct instruction has been defined (c.f., Rosenshine (1979): as being (1) academically focused, (2) teacher directed instruction using sequenced and structured materials, (3) grouping students for learning (where appropriate and where close monitoring and supervision can be provided), (4) emphasis on factual questions and controlled practice, and (5) careful management of students during seat-work.

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Rosenthal & Jacobson, 1968; Salganik, 1980; Silberman, 1970; Weber, 1971). In an effective school, teachers and the principal maintain high expectations for the achievement of all but clearly exceptional students. They assume that regardless of family background or social class characteristics all children can learn at a normal rate and can achieve standard levels of performance during their years of schooling. In an ineffective school, expectations for achievement are neither high nor fixed. Children who enter school with a lower level of reading readiness or who are from lower socio-economic classes (Rist, 1970) are categorized as low achievers. It is assumed that there is little the school can do to offset the impact of preschool, family, and environmental conditions.

According to this hypothesis, appropriateness and intensity of instruction constitutes an institutional response to a perceived learning gap. The perceived learning gap is the difference between expectations teachers and principals hold for students and their perceptions of how well students are actually achieving. It is the perceived learning gap which exerts pressure on teachers and principals to accept professional responsibility for low achieving students and to work institutionally to increase the appropriateness and intensity of instruction for them. In the ineffective school teacher and principal expectations for students regress toward actual achievement, a dynamic which obviates any perceived learning gap and any institutional responsibility for improving instruction. Thus, ineffective schools, are dominated by a positive feedback dynamic which serves to amplify over time initial differences in student achievement. In contrast, effective schools, where the teachers and principal maintain their belief that all but clearly exceptional children can learn at grade level standards, exhibit goal seeking behavior where grade level standards are the performance goals for initially low achievers.

A Dynamic Theory of Schooling

The core of our theory about schooling and instruction is that the student's learning rate for any subject is directly dependent on the amount of time the student is successfully engaged in instructional activities related to that subject. [3] This focus on time and learning draws heavily on the work of the Beginning Teacher Evaluation Study carried out in California since 1972 (Fisher, et al., 1978).

Central to this concept is the notion of "engaged time" in instructional activities, or what the BTES study refers to as "academic learning time". Engaged time depends on time allocated for instruction, student motivation for learning in that particular subject area, and on the appropriateness of the activities planned and presented by the teacher. Activities are appropriate if they are at the right level of reading comprehension, culturally and topically relevant, and properly sequenced with reference to prior learning (cf. Bloom, 1976). Thus, appropriateness is a function of the teacher's "instructional efficiency" with that cohort. A

[3] Although variations in student aptitude are important, they do not change the institutional responses to achievement patterns. In this study, we have assumed that students with different levels of initial achievement have the same aptitude for learning.

teacher's general instructional efficiency for a class depends on the level of teacher skills and on class size. The more highly skilled a teacher is, the more effective he or she is in transforming time allocated to instruction to time on task and in reducing time spent on classroom management and student behavior which increases time allocated for instruction. [4] Time-on-task together with student motivation determines the engaged time in a particular subject. Learning is a function of engaged time; motivation is a function of learning.

The amount of time-on-task for a given achievement group can vary within a class depending on the teacher's emphasis on that group. Students who receive greater emphasis have more time-on-task and higher engaged time than students who receive less emphasis. It is central to our theory of schooling that the perceived learning gap between teacher expectations for achievement and present level of achievement is a major determinant of the teacher emphasis for a particular achievement group. A teacher will devote more emphasis to a particular achievement group if the teacher perceives a gap in reading achievement for that group (reading achievement is below the teacher expectations for that group). If there is no gap between expectations and achievement, there will be no effort to increase the emphasis on a particular achievement group.

Teacher expectations also have a direct impact on teacher emphasis. If teacher expectations are below grade level standards, then we hypothesized that there is a systematic bias against those students for whom the teacher has below-normal expectations. Thus, the teacher who has below-normal expectations for a particular achievement group will place below normal emphasis on the group and have a group instructional efficiency which is less than normal. Therefore, the appropriateness and intensity of instruction and engaged time for that achievement group will also be less than normal. In addition, teacher emphasis is a finite commodity which is allocated among the three achievement groups. Students in various achievement groups compete for teacher emphasis. While a teacher may wish to devote a great deal of his/her time to a particular achievement group, realities dictate that time must also be spent with the other groups.

Student behavior is a central element in the dynamics of learning. Each achievement group's behavior is affected by its motivation to learn in each content area and by the general level of classroom and school-wide behavior. A cohort's behavior also affects the general classroom behavior with larger cohorts having a disproportionate effect. The general level of classroom behavior directly affects the amount of time available for instruction to all students in the classroom and, through out-of-class interactions, affects the behavior of students at other grade levels throughout the school.

The absence of school administrators from this causal theory of instruction is purposeful. School administrators are not directly involved in the instructional process. Their job is one of setting policies, exerting pressure, and improving the staff through in-service or recruitment. In our

[4] Workload pressures also affect a teacher's instructional efficiency. The present stage of research treats workload as an exogenous variable. In our next stage, we will build appropriate structure to make it endogenous.

policy analyses, we assess the impact of principal efforts in these various roles for trying to change an ineffective school into an effective one.

The theory incorporates the idea that the transition to school effectiveness is a developmental process dominated by positive feedback. Success leads to more success. We define success as occurring when the reading achievement gap for initially low-achievers at the end of the sixth grade is less than their initial achievement gap when they entered the first grade. When teachers perceive success, teacher weight for standards begins to rise. A rising weight for standards means higher expectations for achievement at all grade levels. This results in a larger perceived learning gap for low-achieving students and, consequently, more effort and concern on the part of teachers to provide more appropriate and more intense instruction. This leads to further gains in achievement, more success, higher weight for standards, and higher expectations. It is a positive feedback loop that can move a school toward effectiveness. [5]

There are two possible points of intervention to initiate this loop. One is to attempt to raise teachers' weight for standards through recruitment or staff development activities. The second approach is to intervene to change the appropriateness and intensity of instruction by changing teacher emphasis, teacher effectiveness, policies for allocating time, or student behavior. The School Effectiveness Model is designed to test these two major points of intervention.

From Theory to Simulation Model

The basic structural element of the School Effectiveness Model is the student cohort. The cohort is a group of similarly achieving students at a particular grade level at any particular point in time. Thus, in any given year, three cohort groups enter the first grade: a low-achieving cohort, an average-achieving cohort, and a high-achieving cohort. There are also three cohort groups at each of the other grade levels in the school.

The model contains a set of equations for each of the eighteen cohort groups. Each set includes six level equations: Number of Students, Reading Achievement, Achievement in all other subjects, Reading Motivation, Motivation in all other subjects and Behavior. In this model, as students flow through any particular grade, they learn, behave, and are motivated according to conditions affecting them during that time period. The logic of the flow is as follows:

Students enter the grade at the beginning of the school year with the levels of achievement, behavior and motivation with which they exited the prior grade level.

[5] That success and therefore its impact on teachers' weight for standards is tied to initially low-achievers and to reading achievement is consistent with the policy focus of this entire research endeavor. Our concern from the outset has been with the systematic bias against initially low-achievers in urban elementary schools. Our focus is on reading achievement since we share the view with other educators that reading achievement is the key to success in schooling.

These levels undergo certain changes during the current school year; then the students go on to the next grade taking their achievement, behavior and motivation with them. Following them in the next school year is another set of students with their own accumulated levels of achievement, behavior and motivation. Thus, the process continues from year to year.

The model also describes the teaching staff. The school has a teaching staff with an average level of skill and with an average weight for standards which determines their expectations for student achievement. Over time, teachers enter and leave the school and carry with them their attributes of skill and weight for standards. In addition to the normal turnover in staff, teachers can be recruited by the principal to raise staffing level or fired if overstaffed. The average teacher skills and the average teacher weight for standards can be changed through recruitment and turnover and through specific staff development activities initiated by school administrators. The third major component of the model characterizes the general behavioral climate associated with the school. This climate affects students and teachers over and above the effects of the behavior of a particular cohort group or grade level.

The major simplifying assumptions in the model operate to reduce variability. The first of these is that students are of only three kinds: initially high-, average-, and low-achievers. The only parametrized difference among students has to do with initial achievement. The model makes no other assumptions about input characteristics of students but it does simplify the flow of students. In the model, there is no attrition, no gain and no turnover in students either during the school year or between school years. Another simplifying assumption in the model relates to teachers. The model characterizes the average teacher. It specifies no variation among teachers.

It should be noted that the variables and relationships in the model are the same for high-, average-, and low-achievers. It is the values of the variables which are different among the three groups, not the variables or the relationships among them. Other values change responsively over time but the structure is the same for all three groups. It is the structure which generates the subsequent differences among the three groups in motivation, behavior, and learning rate, over and above the initial differences in achievement.

Model parameters are set to replicate conditions typical of urban elementary schools. The student body consists of 450 students distributed equally among the six grade levels. The average class size is 25. The proportion of students in the low-, average-, and high-achiever groups is a ratio of 4 to 5 to 1 (cf. Summers & Wollfe, 1975). The school day is 320 minutes long. Of the 320 minutes, 25% or 80 minutes is spent in non-instructional activities and an additional 10% of the time is set aside for staff development activities. This amount of time is equivalent to one afternoon a week when students go home early and teachers remain. In the base model, the teachers have a "normal" skill level (skill=1) and an average weight for standards of zero (which characterizes an ineffective school). Teachers spend approximately six years at the school.

At the beginning of the simulation run, it is assumed that all students have normal motivation and behavior; that all initially high

achievers regardless of grade are one grade level above average; that all initially average achievers are at grade level; and that all initially low achievers are one grade level below average. These initial conditions are not meant to represent reality in an ineffective school, but rather represent a convenient set of initial starting conditions. It takes a number of years into the run for the model to equilibrate at conditions corresponding to those of an ineffective school. All policy analyses on interventions attempting to improve an ineffective school occur after the model reaches the ineffective school equilibrium.

The Ineffective School Equilibrium

Initially low achievers enter school one year below grade level. They exit the 6th grade about 1.7 years below grade level. The average achievers enter school at grade level and exit approximately .4 years below grade level. The high-achievers entered school one year above grade level and exit .95 years above grade level. How does this pattern arise?

All three cohorts begin with the same level of motivation and behavior. The only initial differences are in achievement. Initially all three groups receive the same amount of instruction. However, the pattern begins to change immediately for the low-achievers as teachers discover that they are below grade level. Since this is an ineffective school where teachers place no weight on grade level standards in setting their expectations for student achievement, they form a set of expectations for the low-achievers that is below grade level standards. This lower set of expectations results in a lower desired emphasis which is further lowered by their bias against students for whom they have low expectations. Lower emphasis means a lower instructional efficiency for that cohort and less appropriate and intense instruction. Less appropriate and less intense instruction translates into less engaged time. The motivation of the low-achievers begins to diminish quite rapidly as the students perceive that their achievement is below grade level standards. Low motivation and inferior instruction combine to affect patterns of behavior and learning which further reduce relative achievement. Continued low achievement simply reinforces declining teacher expectations for and emphasis on these children.

The high-achievers, on the other hand, have a rising motivation for reading as they perceive that their achievement is above standards and that they are doing very well. There is no reduction in teacher emphasis for the high achievers. The amount of engaged time that the high-achievers have for reading increases slightly over the course of the year. This increase in engaged time comes not from increases in the appropriateness and intensity of instruction delivered by the teacher but rather comes from the heightened motivation of the initially high-achievers.

There is in fact a decline in the appropriateness and intensity of instruction delivered to the initially high achieving students. Reductions in the appropriateness and intensity of instruction for all students results initially from the decline in lower cohort behavior. As the amount of time that a teacher must spend in dealing with student behavior increases, less time is available for reading instruction. The global effect is to minimize learning for all students. The greatest negative impact is on initially low-achieving students. However, average student achievement also falls gradually below normal and even high-achievers lose a fraction of their

initial grade level advantage by the time they exit sixth grade. Only their persistent level of motivation keeps them from losing more of their early advantage. After six years of ineffective schooling, all student learning has suffered, low-achievers have suffered the most, and the achievement gap among the three cohorts has increased by more than thirty percent.

Policy Analysis

There are four classes of interventions that school administrators can make to try to improve reading achievement for initially low-achievers. The first class has to do with changing the size or the demographics of the student population. Attempts are made to bring about an effective school through changing student inputs. The second class of changes focuses on improving the intensity or quantity of instruction for the initially low-achievers. This could be accomplished either by policies aimed specifically at increasing the intensity of reading instruction for low-achievers or it could occur through grade level or school-wide policies aimed generally at improving the total time available for instruction. The third class of changes are those which aim to increase the appropriateness of the instruction for initially low-achievers. The focus is on affecting the way teachers make decisions about instruction and on affecting their general level of teaching skills. The fourth class of changes are those which focus on the school climate and, in particular, on student behavior.

Some of these changes are focused specifically on the low-achievers and have no direct impact on the other achievement groups. Other policies require diverting resources away from the average and high achieving groups to low-achievers. Most of the policies, though, are ones which are school-wide or grade level policies and affect all three achievement groups.

Policies dealing with modifications in environmental conditions were represented by changes in initial parameters. All other policy interventions were implemented only after the model had reached the ineffective school equilibrium (1981-82 school year). Policies were implemented for five year, ten year, and indefinite periods of time. Policies were tested for different levels of intensity and for different target audiences (i.e., grades 1-6 vs. grades 1-3 vs. grades 4-6).

There has been no effort at this stage of the analysis to deal with organizational responses to attempted policy interventions. We have simply assumed at this point that the principal has the necessary time, skill and rapport with the faculty to accomplish the intended interventions. In our next phase of policy analysis (1982-4) we will seek to incorporate explicit model structure which relates to principal time, principal skills, and staff resistance to change.

Changes in the Student Body

School Size. The base run appeared to produce model behaviors reasonably consistent with observed trends in real schools. The next stage of the work was to examine the behavior of the model under conditions representing different environmental conditions. Model parameters were modified to test the effects of changing school size, the relative proportion of low achievers in the school, their initial level of achievement, the level

of teachers skills and varying class sizes. The purpose of these tests was to generate data on changes in achievement patterns relative to changing environmental conditions which could then be compared with data found in the research literature.

The model is formulated so that school size has a direct impact on school-wide student behavior. The larger the school the more difficult it becomes to maintain levels of good behavior. There also tend to be more students with poor behavior. As the numbers increase, one approaches a critical mass where these students have a negative effect on the entire school climate which is greater than their actual numbers might suggest. Schools that are smaller in size are easier to control and easier to maintain a good discipline environment. The numbers of students with behavior problems are smaller even with the same general level of school-wide behavior.

The effects of school size on school-wide student behavior are played out in the classroom. Schoolwide student behavior affects classroom behavior. For example, if the hall, lunch room and playground are chaotic, that chaos is carried over into the classroom where it affects classroom behavior. The classroom behavior in turn directly affects the amount of time that teachers must spend dealing with behavior. Consequently, a worsening general school climate lowers classroom behavior, increases time in class spent on behavior, decreases time available for instruction and which, in turn, reduces students' engaged time for learning. Results of changes in school size are displayed in Figure 1. School size affects all achievement cohorts but, again because of their marginal motivation, low-achievers are impacted more severely than average- and high-achievers.

SCHOOL SIZE	LOWER COHORT ACHIEVE- MENT	AVERAGE COHORT ACHIEVE- MENT	UPPER COHORT ACHIEVE- MENT	SCHOOL WIDE BEHAVIOR	TEACHER WEIGHT FOR STANDARDS	AVERAGE 6TH GRADE ACHIEVE- MENT
150	5.58	7.04	8.13	1.08	0.0	6.54
300	5.44	6.91	8.01	1.02	0.0	6.43
450 *	5.32	6.79	7.92	0.98	0.0	6.31
600	5.20	6.66	7.81	0.94	0.0	6.19
750	4.99	6.44	7.63	0.87	0.0	5.97
900	4.82	6.25	7.47	0.81	0.0	5.80

* = Base Run

Fig. 1. Effects of School Size on Reading Achievement
(as reflected in achievement at the end of the
sixth grade in the 1980 school year)

Proportion of Low-Achievers in the Student Body. Increasing the number of low-achievers in the student body has a negative impact not only on low-achievers but on all students (Fig. 2). This negative impact is due to the increasing influence of the behavior of the low achieving cohort on classroom and school-wide behavior. As their percentage increases throughout the school, they achieve a critical mass in the classrooms where their lower levels of behavior and increasing numbers have a disproportionate effect on the general behavior in the classroom. This reduces the time available for instruction and penalizes both the low-achievers and the other achievement groups as well. There is evidence of this effect in the research literature (cf. Duke, 1980; Kozol, 1967; Ryan, 1970; Summers and Wolfe, 1975).

LOWER COHORT FRACTION	LOWER COHORT ACHIEVE- MENT	AVERAGE COHORT ACHIEVE- MENT	UPPER COHORT ACHIEVE- MENT	SCHOOL WIDE BEHAVIOR	TEACHER WEIGHT FOR STANDARDS	AVERAGE 6TH GRADE ACHIEVE- MENT
0.013	5.55	7.02	8.11	1.00	0.0	7.17
0.20	5.46	6.94	8.04	0.99	0.0	6.79
0.40 *	5.32	6.79	7.92	0.98	0.0	6.31
0.60	5.17	6.62	7.78	0.96	0.0	5.82
0.80	5.00	6.45	7.63	0.95	0.0	5.32
0.92	4.90	6.34	7.54	0.94	0.0	5.03

* = Base Run

Fig. 2. Effects of the Fraction of Low Achievers in the School on Reading Achievement (as reflected in achievement at the end of the sixth grade in the 1980 school year) [6]

[6] It is important to note that "average achievement scores" artificially inflate the apparent negative effects of increasing the fraction of low-achievers in the school. Reporting these "averages" fails to distinguish between the structural effects of changing the proportion of low-achieving students in a school and the simple arithmetic effects of having more students with low scores. Increasing the fraction of low-achievers does alter the learning environment for average- and high-achievers but not nearly so much as the "average achievement scores" would suggest. Reporting techniques should be closely scrutinized.

Initial Achievement of Low-Achievers. Varying the initial level of reading achievement for low-achievers entering the first grade has an indirect impact on other achievement groups in the school (Fig. 3). In the real world, these variations in initial achievement might be the result of demographic changes in the community or of pre-school reading readiness programs such as Head Start. The effects of the initial achievement of low-achievers play themselves out through the circular effects of achievement on motivation, motivation on behavior, motivation and behavior on learning, and learning back on achievement. A reduction of 0.5 years in lower cohort initial achievement results in a 0.72 years reduction in sixth grade achievement. Similarly, a reduction of 1.0 years in lower cohort initial achievement results in a 1.64 years reduction in sixth grade achievement. Lesser effects occur for other achievement cohorts (Fig. 3).

INITIAL LOWER ACHIEVE- MENT	LOWER COHORT ACHIEVE- MENT	AVERAGE COHORT ACHIEVE- MENT	UPPER COHORT ACHIEVE- MENT	SCHOOL WIDE BEHAVIOR	TEACHER WEIGHT FOR STANDARDS	AVERAGE 6TH GRADE ACHIEVE- MENT
+0.5	6.19	6.91	8.02	0.99	0.0	6.73
0.0*	5.32	6.79	7.92	0.98	0.0	6.31
-0.5	4.40	6.65	7.80	0.97	0.0	5.86
-1.0	3.68	6.53	7.70	0.96	0.0	5.50

* = Base Run

Fig. 3. Effects of the Initial Achievement of Entering Low Achievers on Reading Achievement (as reflected in achievement at the end of the sixth grade in the 1980 school year)

Teacher Skills. The effect of teacher skills on school achievement patterns is more complex - particularly with increasing levels of skill. In these simulations, average or normal skill is given a value of 1.0, higher levels of skill are greater than 1, and lower levels of skill are less than 1. It is our belief that it is very difficult to obtain an average skill level of 1.5 for an entire school faculty and that this would take an extraordinary amount of effort on the part of the administrators and the teachers. We think it much more reasonable that a good staff development program might achieve an average skill level of 1.1 or 1.2. [7] Therefore, the model incorporates

[7] Unfortunately, the research literature on staff development does not

asymptotic effects of staff development on teacher skills and exponential effects of teacher skills on student learning (Fig. 4).

TEACHER SKILLS	LOWER COHORT ACHIEVE- MENT	AVERAGE COHORT ACHIEVE- MENT	UPPER COHORT ACHIEVE- MENT	SCHOOL WIDE BEHAVIOR	TEACHER WEIGHT FOR STANDARDS	AVERAGE 6TH GRADE ACHIEVE- MENT
1.5	7.62	8.29	9.40	1.06	0.999	8.12
1.3	7.02	7.05	8.14	1.02	0.999	7.14
1.1	5.56	7.02	8.11	0.99	0.0	6.53
1.0 *	5.32	6.79	7.92	0.98	0.0	6.31
0.9	5.21	6.67	7.82	0.98	0.0	6.20
0.7	4.72	6.15	7.40	0.96	0.0	5.69
0.5	3.66	5.07	6.41	0.91	0.0	4.63

* = Base Run

Fig. 4. Effects of Teacher Skills on Reading Achievement (as reflected in achievement at the end of the sixth grade in the 1980 school year)

The sudden rise in achievement of initially low-achievers when teacher skill is above 1.3 is a result of two interactive effects. Not only do teacher skills at that level have a marked direct impact on student learning, but this observed improvement in learning also puts upward pressure on teacher weight for standards for initially low-achieving students. This, in turn, drives teacher expectations upward and motivates greater instructional emphasis on low-achievers, which further enhances their learning.

Not only does the model describe the main effects of teacher skills on student learning as non-linear; it also incorporates an interaction effect on learning of teacher skills and class size. Highly skilled teachers take better advantage of small class sizes and are less negatively affected by large class sizes. Minimally skilled teachers take little advantage of small

quantify the acquisition of teacher skills in this fashion. However, it seems intuitively reasonable that incremental changes become increasing more difficult as the level of skills moves further from the mean.

class sizes and have marked difficulty in teaching effectively classes much larger than normal.

Class Size. The effects of changes in class size on achievement patterns are consistent with observed research patterns (Educational Research Service, 1978). For teachers with average skills, reductions in class size produce minimal positive effects on student achievement (Fig. 5).

CLASS SIZE	LOWER COHORT ACHIEVE- MENT	AVERAGE COHORT ACHIEVE- MENT	UPPER COHORT ACHIEVE- MENT	SCHOOL WIDE BEHAVIOR	TEACHER WEIGHT FOR STANDARDS	AVERAGE 6TH GRADE ACHIEVE- MENT
10	5.58	7.04	8.13	0.99	0.0	6.56
15	5.46	6.93	8.03	0.99	0.0	6.45
20	5.35	6.81	7.94	0.98	0.0	6.33
25 *	5.32	6.79	7.92	0.98	0.0	6.31
30	5.30	6.77	7.90	0.98	0.0	6.29
35	5.19	6.65	7.80	0.97	0.0	6.17
40	5.06	6.52	7.70	0.97	0.0	6.05
50	4.75	6.19	7.42	0.96	0.0	5.73

* = Base Run

Fig. 5. Effects of Class Size on Reading Achievement
(as reflected in achievement at the end of the
sixth grade in the 1980 school year)

Summary. The results of these interventions suggest that there is no basic change in the patterns of appropriateness and intensity of instruction delivered to the different cohort groups as changes are made in school size, percentage of low-achievers, or entry level achievement of low-achievers. The school is still an ineffective school. The achievement scores may be slightly higher or lower but initially low achieving students still leave the sixth grade with a larger achievement gap than when they entered.

Changes in Intensity of Instruction

Time Allocated to Reading Instruction for Low-Achievers. The class of policies aimed at improving the intensity of instruction for initial low-achievers focus either directly on the low-achievers or on school-wide

policies which affect all achievement groups. One policy is to change the fraction of time allocated to reading instruction for initial low-achievers. Under this policy, teachers increase the amount of time that initially low-achievers spend in reading instruction and decrease the amount of time that they spend in instruction for other subjects. The rationale is that the gains in reading achievement over the long term would offset the short term losses in other areas. There is an assumed interdependence between achievement in reading and achievement in other content areas. First, time spent in reading instruction cannot be spent in instruction in another subject and, second, the level of reading achievement affects student learning in another content areas. Very often, the instructional materials used in other content areas require a level of reading achievement at or above grade level standards. Students whose reading comprehension level is low have difficulty mastering concepts in other subject areas. Conversely, students who have higher reading achievement are able to master concepts in other subject areas more quickly.

In order to test the implications of policies aimed at increasing reading instruction time at the expense of instruction time in other subjects, a sector was added to the School Effectiveness Model which tracks student achievement and motivation in other subject areas. In this sector, all other academic subjects are treated as if they were one subject. The equations for the learning rate in other content areas closely parallel those for the learning rate for reading. The one difference in the formulation of the learning rate for other subject areas is that it also includes the interaction effect of reading achievement on the learning rate in other content areas. Since course materials for other subjects are often written at levels equal to or above grade levels, this effect reduces the learning rate in other content areas if reading achievement is below normal levels and enhances the learning rate if reading achievement is above normal. This effect of reading achievement on other subjects is mediated by the appropriateness and intensity of instruction provided by the teacher in the other content areas. If the instruction is highly appropriate and intense, a below normal level of reading achievement will have less effect on the student learning rate in other content areas than it would if the instruction were less appropriate and less intense. If reading achievement is above grade level and instruction is highly appropriate and intense, reading achievement will have a greater positive effect on the learning rate on other content areas.

LOWER FRACTION READING TIME	LOWER COHORT ACHIEVE- MENT Rdg/Other	AVERAGE COHORT ACHIEVE- MENT Rdg/Other	UPPER COHORT ACHIEVE- MENT Rdg/Other	SCHOOL WIDE BEHAVIOR	TEACHER WEIGHT FOR STANDARDS	AVERAGE 6TH GRADE ACHIEVE- MENT Rdg/Other
0.50 *	5.32 4.89	6.79 6.65	7.92 7.92	0.98	0.0	6.31 6.06
0.55 (1-6)	6.95 5.05	6.90 6.75	7.59 7.57	1.00	0.951	6.99 6.15
0.55 (1-3)	5.90 4.72	6.82 6.68	7.95 7.95	0.98	0.0	6.56 6.02
0.55 (4-6)	5.78 4.64	6.80 6.66	7.93 7.92	0.98	0.0	6.50 5.97
0.60 (1-6)	7.40 4.18	6.97 6.83	7.77 7.76	1.00	0.999	7.22 5.86
0.65 (1-6)	7.82 3.38	6.98 6.85	7.87 7.86	1.00	0.999	7.40 5.55

* = Base Run

Fig. 6. Effects of Changing the Fraction of Time for Reading Instruction for Low Achievers on Achievement (as reflected in achievement at the end of the sixth grade thirty years after the change)

Policy tests were implemented for the length of the run (Fig. 6) and for intermediate periods of time. All runs assumed average teacher skills. Interventions for five or ten year time periods all showed subsequent regressions to the normal ineffective equilibrium mode. A moderate shift (55% vs. 50%) in the balance of time allocated to reading vs. other instruction showed positive long-term results. More drastic shifts had increasingly negative effects on other subject achievement. These results derive mainly from the relationship between two curves: (1) effect of reading achievement on learning in other content areas. vs. (2) effect of instructional time on learning in other content areas. The results suggest the optimal intersection of these curves.

Time Spent on Non-Instructional Activities. Another way to increase the intensity of instruction is to reduce the amount of time spent in non-instructional activities. This might be through reducing the length of recesses, or the lunch period, or reducing the number of assemblies or other activities which take students away from time that could be devoted to academic instruction. It is extremely unlikely that any school administrator would be able to eliminate completely time spent on non-instructional activities. It is more realistic to suggest that the percentage of time on

non-instructional activities could be reduced from 25% of the school day to 20% (or at most 15%) of the school day. These interventions were tested and the results are shown in Figure 7.

FRACTION OF TIME NON-INST. ACTIVITY	LOWER COHORT ACHIEVE- MENT	AVERAGE COHORT ACHIEVE- MENT	UPPER COHORT ACHIEVE- MENT	SCHOOL WIDE BEHAVIOR	TEACHER WEIGHT FOR STANDARDS	AVERAGE 6TH GRADE ACHIEVE- MENT
0.15 (1-6)	7.59	8.22	9.33	1.06	0.999	8.07
0.15 (1-3)	7.01	7.52	8.62	1.03	0.999	7.42
0.15 (4-6)	7.10	7.23	8.20	1.02	0.999	7.27
0.20 (1-6)	7.12	7.41	8.51	1.03	0.999	7.40
0.20 (1-3)	6.96	6.99	8.08	1.02	0.954	7.08
0.20 (4-6)	5.81	7.18	8.28	1.00	0.0	6.74
0.25 *	5.32	6.79	7.92	0.98	0.0	6.31

* = Base Run

Fig. 7. Effects of Changing the Fraction of Time for Non-Instructional Activities on Achievement (as reflected in achievement at the end of the sixth grade thirty years after the change)

Efforts to reduce the amount of time spent in non-instructional activities lead to increases in the total classroom time. This means that for a given class, and teacher, there will be increases in the amount of engaged time for reading. Consequently, decreases in the time for non-instructional activities should improve achievement across the board for all achievement groups. As shown in Figure 7, this is precisely what happens. The greater the reduction in time spent in non-instructional activities the greater the achievement gains.

It should be noted that achievement is very sensitive to changes in time allocations. As Figure 7 shows, reducing non-instructional time from 25% to 15% has virtually eliminated the problem of the reading achievement gap for initially low-achievers. It is our feeling that the School Effectiveness Model is perhaps too tight in its connection between time and learning. In particular, we are concerned that relatively minor changes in time allocations can cumulatively have a significant impact on achievement. We would expect the result to be more moderate. Consequently, we feel that simply reducing time for non-instructional activities as was done in these simulation runs may not produce the dramatic gains in the real school system that are shown here.

Be that as it may, these runs do point out that one important way to improve achievement patterns in the school is to examine carefully the distribution of time during the school day. The elimination of non-essential minutes from the non-instructional time means more time can be devoted to instructional activities.

Varying Class Size across Grade Levels. Educators such as Weber (1971) argue that the primary grades are the most important grades for improving reading achievement and that is much more difficult to achieve improvement after grade 3. A school with fixed resources might try to improve instruction in the primary grades by reducing class sizes in the primary grades and increasing class sizes in the intermediate grades. This would provide more student-teacher contact in the primary grades and should enhance the appropriateness of instruction. Teachers with smaller classes would also find it easier to maintain discipline. Consequently, they should spend less time responding to behavior problems and have more time available for instruction. Although the reverse would be true at the upper grade levels, the assumption is that gains in reading achievement at the lower levels would offset the problems associated with larger class sizes in the upper grades. Even though the classes at the upper level are larger, students have higher levels of achievement, motivation and behavior than they would otherwise have.

On the other hand one could argue that it would be more effective to have large class sizes at the primary level and smaller class sizes at the intermediate level. Small class sizes at the intermediate level would enable one to more easily bring students up to grade level. Those teachers would be more effective and the larger class sizes would not hurt students at the primary level because they still have high levels of motivation and behavior. Figure 8 compares the results of the base run in which class size in every grade is equal to twenty-five with those of test runs in which class size varies from fifteen in grade one to forty in grade six, and vice-versa.

LOWER COHORT ACHIEVE- MENT	AVERAGE COHORT ACHIEVE- MENT	UPPER COHORT ACHIEVE- MENT	SCHOOL WIDE BEHAVIOR	TEACHER WEIGHT FOR STANDARDS	AVERAGE 6TH GRADE ACHIEVE- MENT
<hr/>					
Increasing Class Sizes from Gr. 1 = 15 to Gr. 6 = 40					
5.30	6.76	7.89	0.98	0.0	6.29
Decreasing Class Sizes from Gr. 1 = 40 to Gr. 6 = 15					
5.18	6.64	7.81	0.97	0.0	6.16
Uniform Class Sizes (Base Run)					
5.32	6.79	7.92	0.98	0.0	6.31

Fig. 8. Effects of Varying Class Sizes Among Grades on Achievement (as reflected in achievement at the end of the sixth grade thirty years after the change)

The results shown in Figure 8, suggest that smaller class sizes in the primary grades are better than large class sizes at the primary level but that neither choice yields achievement patterns as high as those with uniform class size. The degradation in achievement, motivation and behavior that occurs with large class sizes in the primary grades is too great to be neutralized by small class sizes in the upper grade. These results suggest that redistributing a constant number of teachers among grade levels for a constant student body will have no beneficial impact on ameliorating the problem and that, in fact, the policy will make matters worse.

Reducing Class Size by Adding Staff. A more popular school improvement strategy is to say that an ineffective school can be turned around by increasing the staff to reduce class sizes. Students will get more personal attention, both the appropriateness and the intensity of instruction will improve, and the achievement gap will be closed for the initially low-achievers. The results of Figure 5 suggests that this is not the case (Supra p. 14). Reducing the class size has had only modest effects on the achievement patterns of all three cohort groups. The teachers' level of skills has not improved, they have not increased the weight they give to standards and their expectations have not changed. As a consequence, the same patterns persist when the class sizes are 15 as when they are 25 or 30. A variation of this policy would be to increase both the size and quality of the staff by hiring new teachers who have better skills or who have higher weight for standards than the teachers currently on the faculty. The ability to mount this type of recruitment campaign would probably be linked to the availability of outside funding (e.g. federal monies) and would probably be of a relatively short duration.

Tests of modest (10%) changes in new staff characteristics (i.e., skills or standards) showed minimal effects. Short-term (i.e., five or ten

year policy interventions) showed little or no lasting effects over thirty years. Indefinite interventions showed moderate effects on lower-cohort achievement (.29 grade levels in response to a ten percent increase in replacement teacher skills; .19 grade levels in response to a ten percent increase in replacement teacher standards). Recruiting more skillful teachers has more impact than recruiting teachers with higher standards.

The problem with these interventions aimed at improving teacher effectiveness through recruitment is that unless one recruits large numbers of teachers for example, double or triple the size of the staff, the percentage of new teachers in the total faculty is small and their enhanced skills or enhanced weight for standards is diluted by their low numbers. This would suggest that the more effective way to raise teacher skills or to raise teacher expectations would be through staff development activities.

Summary. The class of interventions aimed at improving the intensity or quantity of instruction for initially low-achievers produces mixed results. The only policy that results in clear and significant gains in achievement patterns is that aimed at reducing time spent on non-instructional activities.

Changes in Appropriateness of Instruction

The third class of policy interventions focuses on improving the appropriateness or quality of instruction for the initially low achievers. Each of the three policies considered here requires the principal to work closely with the faculty, either through staff development activities during the release time for in-service or through observation and interaction with teachers in the classroom.

Changes in Desired Teacher Emphasis. The first of these policies is one aimed at persuading teachers to change the emphasis they place on the low achieving cohort. The presumption in the test runs is that the teachers begin with zero weight for standards (i.e., they use observed student performance as their sole criterion for setting expectations, as opposed to using grade level standards as a criterion for setting expectations). In the different test runs, the principal is seeking to influence teachers to give more weight in setting expectations for students to grade level standards vs. observed performance (i.e., to influence teachers to believe that low-achieving students are capable of achieving grade level standards). The Percent Weight for Principal Emphasis is a measure of the amount of pressure the principal is exerting on teachers to change their expectations.

PERCENT WEIGHT FOR PRINCIPAL EMPHASIS	LOWER COHORT ACHIEVE- MENT	AVERAGE COHORT ACHIEVE- MENT	UPPER COHORT ACHIEVE- MENT	SCHOOL WIDE BEHAVIOR	TEACHER WEIGHT FOR STANDARDS	AVERAGE 6TH GRADE ACHIEVE- MENT
0% *	5.32	6.79	7.92	0.98	0.0	6.31
20%	6.45	6.59	7.46	1.00	0.453	6.61
40%	6.55	6.57	7.35	1.00	0.562	6.64
60%	6.60	6.56	7.29	1.00	0.608	6.65
80%	6.63	6.56	7.24	1.00	0.638	6.65
100%	6.65	6.56	7.21	1.00	0.661	6.65
80% (1986)	5.82	6.85	7.95	0.99	0.032	6.54
80% (1991)	6.26	6.68	7.68	0.99	0.289	6.61
80% (1-3)	5.97	6.61	7.78	0.99	0.0	6.46
80% (4-6)	6.61	6.56	7.31	1.00	0.619	6.65

* = Base Run (1986) = Policy off in 1986 (1991) = Policy off in 1991

(1-3) = Primary Grades Only (4-6) = Intermediate Grades Only

Fig. 9. Effects of Varying Principal Pressure to Change Teachers' Desired Emphasis for Initially Low Achievers (as reflected in achievement at the end of the sixth grade thirty years after the change)

As the amount of principal pressure increases, however, the returns on achievement diminish. More and more principal effort devoted to changing teacher emphasis does not produce corresponding gains in achievement. The reason for this is that a classroom teacher must also respond to the needs of the other achievement group and will not devote one hundred percent of his or her emphasis to any one achievement group. As a consequence, the actual teacher emphasis for the low-achievers is less than the desired emphasis.

Furthermore, as the amount of emphasis increases on the low-achievers, it is primarily the initially high-achievers who suffer the greatest cutback in teacher emphasis and, therefore, appropriateness and intensity of instruction. The declines in high achiever scores are approximately twice the size of the declines for the initially average-achievers. As a consequence, efforts aimed at increasing teacher emphasis on the initially low-achievers mean the diversion of teacher emphasis from the other achievement groups and

particularly the initially high achievers. The work of Weaver (in press) suggests that there is probably a threshold point below which the initially high-achievers and their parents will no longer tolerate the degradation of their achievement scores, a point at which pressure would be brought to bear on the school administrators to reverse the policy.

A contrasting pattern emerged when attempts were examined to change teacher emphasis patterns for a fixed amount of time and then to discontinue the policy. The pattern which emerged in short term interventions was one which was characterized by a slow regression back to the original ineffective school conditions.

The policy was also tested to determine whether it was more effective with a school-wide focus or only on the primary grades or the intermediate grades. The results shown in Figure 9 indicate that the policy applied to all grades is most effective and least effective when applied only to the primary grades. If applied selectively, it is of greatest value in the upper grades where under normal ineffective school conditions the desired teacher emphasis on the initially low-achievers is far lower than it is in the primary grades.

The results of policies to change teacher expectations showed patterns similar to those of the policies described to alter teacher emphasis. Short term policies aimed at improving teacher expectations do not produce lasting results. This is in part due to the fact that the weight for standards of new teachers entering the school to replace leaving teachers lags behind the average weight for standards of the current faculty. Consequently, without continued staff development activities there is, over time, a slow degradation of the weight for standards back to its initial level. This dynamic is further exacerbated by the fact that as teacher weight for standards declines, it means less emphasis on the initially low-achievers, lower achievement, and a lowered indicated level for the weight for standards which further drives down the teacher weight for standards.

Thus, as in the case of interventions aimed at changing teacher emphasis, ongoing policies which involve staff development activities to change expectations are more beneficial than short term "on-off" policies. However, these policies alone cannot accomplish the goal of eliminating the achievement gap and gains by the initially low-achievers are at the expense of the other achievement groups.

Resistance to Change. Although the model does not explicitly deal with resistance to change on the part of the school faculty, some elements of that phenomenon are incorporated in the equations dealing with changing teacher expectations. The research literature on change (cf. Gaynor, 1981; Klein, 1976) argues that incremental changes are easier to achieve than radical changes, particularly when one is trying to change attitudes and values. This means that larger changes should take longer to achieve than smaller ones. The model accomplishes this by making the adjustment time, the time it takes teacher weight for standards to change from its present level to a new desired level through staff development, dependent on the size of the change desired.

There is another element of staff resistance in changing the weight for standards. Upward pressure as a result of staff development activities on teacher weight for standards will be counteracted by downward pressure on the

indicated weight for standards from achievement unless there are gains in achievement for the initially low-achievers. This suggests that policies aimed at changing teacher expectations might be facilitated by also pursuing policies which would enhance reading achievement independently of raising teacher expectations (e.g., policies aimed at changing the fraction of time devoted to reading instruction, improving teacher skills, or reducing the amount of time on non-instructional activities).

Improving Teacher Skills. The improvement of teacher skills through staff development activities has pay-offs associated both with improving the appropriateness and the intensity of instruction. Enhanced teacher skills increase teacher effectiveness and instructional efficiency for a class. Increased teacher skills also mean that teachers are more effective in dealing with behavior problems and in classroom management activities and, therefore, are able to reduce the amount of time they spend on behavior. This leads to increased amounts of time available for instruction and gains in engaged time for student learning. As in the case of changing teacher expectations, our theoretical stance has been that it is more difficult to effect large changes in teacher skills and that it is easier to achieve improvement in teacher skills through steady, incremental changes. In the policy tests described (Fig. 10), it was assumed that staff development activities could be implemented in the time set aside for in-service training. When time for staff development activities is achieved by reducing the time available for instruction, gains associated with those staff development activities are largely erased by the losses in student achievement due to reduced time available for instruction.

FRACTION IN-SERVICE TIME TO CHANGE SKILLS	LOWER COHORT ACHIEVE- MENT	AVERAGE COHORT ACHIEVE- MENT	UPPER COHORT ACHIEVE- MENT	SCHOOL WIDE BEHAVIOR	TEACHER WEIGHT FOR STANDARDS	AVERAGE 6TH GRADE ACHIEVE- MENT
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Desired Teacher Skills = 1.3

0.00 *	5.32	6.79	7.92	0.98	0.0	6.31
0.10	5.77	7.17	8.27	1.00	0.0	6.72
0.30	7.10	7.38	8.47	1.03	0.999	7.37
0.50	7.11	7.38	8.48	1.03	0.999	7.37
0.70	7.11	7.38	8.48	1.03	0.999	7.37

0.30 (1986)	6.56	7.11	8.20	1.01	0.419	6.99
0.30 (1991)	7.05	7.21	8.30	1.02	0.999	7.24

Desired Teacher Skills = 1.5

0.70	7.90	8.73	9.84	1.08	0.999	8.50
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Desired Teacher Skills = 1.3

0.70	7.11	7.38	8.48	1.03	0.999	7.37
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Desired Teacher Skills = 1.1

0.70	5.64	7.08	8.17	0.99	0.0	6.61
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* = Base Run (1986) = Policy off in 1986 (1991) = Policy off in 1991

Fig. 10. Effects of Devoting In-Service Time to Improving Teacher Skills (as reflected in achievement at the end of the sixth grade thirty years after the change)

Policies aimed at changing teacher skills seems to be the most effective for eliminating the achievement gap, provided the amount of time spent in skill improvement activities is sufficient to raise the average level of teacher skills 20 to 30% above normal. Teachers with enhanced skills have greater instructional efficiency which improves the appropriateness of instruction. They are more effective dealing with student behavior which increases the intensity of instruction. As a consequence, achievement improves and with it teacher weight for standards. Short term policies are almost as effective as long term policies. The differences between skill

development over a ten year period, over five year period, and over an indefinite period are negligible. The reason for this is that it is assumed in the model that new teachers entering the school as a result of staff turnover will have roughly the same level of teaching skills and weight for standards as the present faculty. We contend that an effective school with teachers who are highly skilled and who have high expectations will attract the same kind of teachers to the school, and that this is particularly true in a time of teacher surplus.

As the model is presently constructed there are no negative effects of improving teacher skills. However, that is not to say that negative consequences might not exist. For example, it may be that it is impossible to achieve a 30% increase in average teacher skills without requiring more time for staff development. If that were the case, the increase in teacher skills would come at the expense of less time available for instruction, and the gains from enhanced teacher skills would be reduced. Another potential impact might be that concerted efforts to raise teacher skills would increase teacher workload and, therefore, reduce instructional efficiency. These issues will be dealt with in the next stage of policy analysis (1982-4).

Changes in School Climate

The final class of policy interventions focused on efforts to improve the school climate. Although there are many ways to change school climate, we focused on two specific climate interventions: improving classroom behavior through efforts by the teachers and improving school-wide behavior through efforts by the principal. Improving student behavior either at the classroom or school-wide level should lead to increased time available for instruction which should increase engaged time and raise achievement for all achievement groups. However, if it is school policy that teachers spend part of their classroom time each day devoted to activities specifically designed to improve student behavior, the time spent in these activities comes out of time available for instruction (unless there is also a reduction in time spent in non-instructional activities). As a consequence, gains in behavior and the derived gains in time for instruction are offset by the direct loss in time available to instruction. The impact of these conflicting pressures on time shows up clearly in the resulting achievement patterns when this policy is implemented (Fig. 11).

FRACTION CLASSROOM TIME TO IMPROVE BEHAVIOR	LOWER COHORT ACHIEVE- MENT	AVERAGE COHORT ACHIEVE- MENT	UPPER COHORT ACHIEVE- MENT	SCHOOL WIDE BEHAVIOR	TEACHER WEIGHT FOR STANDARDS	AVERAGE 6TH GRADE ACHIEVE- MENT
0.00 *	5.32	6.79	7.92	0.98	0.0	6.31
0.01	5.18	6.64	7.80	0.98	0.0	6.16
0.05	4.63	6.07	7.33	0.96	0.0	5.61
0.05 (1-3)	4.87	6.32	7.55	0.96	0.0	5.86
0.05 (4-6)	5.08	6.52	7.69	0.98	0.0	6.05
0.10	3.98	5.40	6.74	0.94	0.0	4.96
0.20	2.72	4.09	5.46	0.91	0.0	3.67

* = Base Run (1-3) = Primary Grades Only (4-6) = Intermediate Grades Only

Fig. 11. Effects of Changing the Fraction of Time for Improving Classroom Behavior on Achievement (as reflected in achievement at the end of the sixth grade thirty years after the change)

On the other hand, policies aimed at improving school-wide behavior do not detract from classroom instructional time. These policies represent efforts on the part of school administrators to improve student behavior in the halls, lunchroom, playground, before, during and after school. These are policies that are not directed at any one cohort group or any one grade level but rather are policies directed at all students in the school. The results of principal interventions to change school-wide behavior are showned in Figure 12. These efforts to improve school-wide behavior are a function not only of the principal's effectiveness but also of the size of the student body and the amount of time that the principal has available to devote to the effort.

FRACTION PRINCIPAL TIME TO IMPROVE BEHAVIOR	LOWER COHORT ACHIEVE- MENT	AVERAGE COHORT ACHIEVE- MENT	UPPER COHORT ACHIEVE- MENT	SCHOOL WIDE BEHAVIOR	TEACHER WEIGHT FOR STANDARDS	AVERAGE 6TH GRADE ACHIEVE- MENT
0.00 *	5.32	6.79	7.92	0.98	0.0	6.31
0.10	5.43	6.90	8.01	0.99	0.0	6.42
0.20	5.53	7.00	8.09	1.00	0.0	6.51
0.30	5.58	7.04	8.13	1.00	0.0	6.55
0.30 (1986)	5.32	6.79	7.92	0.98	0.0	6.31
0.30 (1991)	5.32	6.79	7.92	0.98	0.0	6.31

* = Base Run (1986) = Policy off in 1986 (1991) = Policy off in 1991

Fig. 12. Effects of Changing the Fraction of the Principal's Time for Improving School-wide Behavior on Achievement (as reflected in achievement at the end of the sixth grade thirty years after the change)

The data in Figure 12 suggest that continued efforts on the part of the principal to improve schoolwide behavior have modest positive effects but that short-term policies merely produce temporary gains. Furthermore, the data suggest that a principal spending all his time trying to improve behavior would not be much more effective than a principal who spends only ten to twenty percent of his time. Part of the reason for this is that the strongest determinant of student behavior as the model is formulated is the student motivation for learning in reading and in other content areas. As a consequence, efforts to raise the level of student behavior above levels which are indicated by the student's motivation to learn are eroded by the downward pressure of behavior indicated by student motivation. The greater the efforts to raise behavior, the more this neutralizing effect occurs.

Conclusion

The research described above has had two main goals: to develop a causal theory for understanding the problem of a reading achievement gap for initially low achievers in urban elementary schools; and to evaluate, using a System Dynamics computer simulation model, the likely consequences of policies implemented by school administrators to ameliorate the problem. The dynamic hypothesis and the theory developed focus on the important role of expectations in shaping teacher decisions about the appropriateness and intensity of instruction for low-achievers.

The School Effectiveness Model simulates the flow of successive cohorts of students, divided according to initial reading achievement, through a six grade elementary school. Students carry attributes of achievement, motivation and behavior from grade to grade. These attributes are modified by the instructional process at each grade. The model was tested under a variety of environmental conditions to assess its robustness before beginning policy analysis.

Policy analysis to date has focused on the separate effects of twelve possible policy interventions clustered in four areas: changes in the quantity of instruction, changes in the quality of instruction, changes in student inputs or school demographics, and changes in school climate. Some of these policies, such as decreasing time for non-instructional activities are aimed at all students while other policies, such as increasing reading instruction time for the low achievers, focus specifically on the low achievers. Results show that policies which, for any reason, reduce the amount of time available for instruction are detrimental to student achievement, while policies aimed at increasing the time allocated for instruction are helpful. Reducing class size through recruitment had only negligible results, even when the additional staff had enhanced skills. Efforts aimed at improving the quality of instruction focused primarily on teacher skills, teacher emphasis on achievement groups, and teacher expectations. Attempts to raise teacher expectations or shift teacher emphasis reduced but did not eliminate the gap because of the competing demands of other achievement groups. Improving skills through staff development does make a difference, and leads to higher expectations, provided there is sufficient improvement. Direct efforts to improve behavior were detrimental if they took time away from instruction and only marginally helpful otherwise.

In the months that remain in this phase of work we shall explore the effects of pursuing combinations of these policies. In the next phase of work (1982-1984) we wish to extend our theory building efforts to incorporate the organizational responses to efforts to introduce change (i.e. staff resistance to change) and limitations on the principal's time and skill for change. We also believe that more work needs to be done in validating the theory by continued literature research and by empirical work in schools which are currently involved in the transition to effectiveness. This paper represents only a beginning.

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1. ACCESS TO MODEL:

Name of Model: School Effectiveness Model

Name and current address of the senior technical person responsible for the model's construction: Karl H. Clauset, Jr.
Box 526, Brookline, MA 02146

Who funded the model development? Not Funded

In what language is the program written? Dynamo II

On what computer system is the model currently implemented? IBM 370/168

What is the maximum memory required to store and execute the program? 1000 K BYTES

What is the length of time required for one typical run of the model? 40 Seconds CPU

Is there a detailed user's manual for the model? No

2. PURPOSE OF THE MODEL:

For what individual or institution was the model designed? Karl H. Clauset, Jr. and Alan K. Gaynor

What were the basic variables included in the model?

Number of Students

Number of Teachers

Student Achievement

Teacher Skills

Student Motivation

Teacher Weight for Standards

Student Behavior

Teacher Emphasis on Achievement Groups

Over what time period is the model supposed to provide useful information on real world behavior? 0 - 50 Years

Was the model intended to serve as the basis of:

an academic exercise designed to test the implications of a set of assumptions or to see if a specific theory would explain historical behavior

X

communication with others about the nature and implications of an important set of interactions

X

projecting the general behavioral tendencies of the real system

X

predicting the value of some system element(s) at some future point in time

3. MODEL SPECIFICATION AND THEORETICAL JUSTIFICATION:

Provide two diagrams illustrating the extreme behavior modes exhibited by the major model elements: Diagrams contained in detailed project description.

Please address inquiries to:

Prof. Alan K. Gaynor

Educational Leadership Program

School of Education

Boston University

605 Commonwealth Avenue

Boston, MA 02215

If they are not included in the body of the paper indicate where the reader may find:

a model boundary diagram that indicates the important endogenous, exogenous and excluded variables

Please contact Authors

a causal influence diagram, a flow diagram, the computer program and definitions of the program elements

Please contact Authors

Is the model composed of:

simultaneous equations X

difference or differential equations

procedural instructions

Is the model deterministic X or stochastic

continuous X or discrete

4. DATA ACQUISITION

What were the primary sources for the data and theories incorporated in the model?

Data National Center for Educational Statistic and the Effective Schooling Research

Theory Research and case study literature on effective teaching and schooling

What percent of the coefficients of the model were obtained from:

measurements of physical systems

inference from social survey data 50%

econometric analyses

expert judgment 20%

the analyst's intuition 30%

What was the general quality of the data? Poor

5. PARAMETER ESTIMATION

If they are not given in the publication, where may the reader obtain detailed information on the data transformations, statistical techniques, data acquisition procedures, and results of the tests of fit and significance used in building and analyzing the model? Not available

6. MODEL PERFORMANCE AND TESTING

Over what period was the model's behavior compared with historical data?

Present period - reference data is difficult to obtain

What other tests were employed to gauge the confidence deserved by the model?

Simulation under a variety of environmental conditions, review of theory and major assumptions by a group of selected researchers and practitioners.