DIFFERENT KIDS—HOW TYPICAL SCHOOLS ARE BUILT TO FAIL AND NEED TO CHANGE: A STRUCTURAL ANALYSIS

by Alan Kibbe Gaynor
Boston University

Abstract: This article uses computer simulation analysis to illustrate the thesis that the typical American public school is structured in a way that *reinforces* the entry characteristics of its students so that by the time they graduate after twelve years—if they graduate—students who enter the school in kindergarten or first grade with high "readiness" perform academically better-than-average while students who enter the school with low "readiness" perform worse than average, this creating the well-known and widely discussed "achievement gap."

The conclusion of this argumentation is that this structure must be changed if school reform is to be effective and that it is strong school leadership that over time builds teacher quality and community and parent interest in the school and changes teacher expectations for all students, especially for initially and traditionally low-achieving students.

The position taken in the paper, and supported by the computer simulation modeling data, is that, in this way, strong school leadership enhances the quality and intensity of instruction, the closeness of student-teacher relationships, and the rigor of instructional content for all students, thus drawing further advances in student motivation, work effort, and academic performance, and, finally, improving the attractiveness of the school for high quality teachers and continuing the upward cycle.

INTRODUCTION

In this article I renew and expand upon an argument that Karl Clauset and I first made some thirty years ago (Clauset & Gaynor, 1982). The main point of this argument is that the typical American public school is structured in a way that *reinforces* the entry characteristics of its students so that by the time they graduate after twelve years—if they graduate—students who enter the school in

kindergarten or first grade with high "readiness" perform academically better-than-average while students who enter the school with low "readiness" perform worse than average, this creating the well-known and widely discussed "achievement gap."

School readiness includes such things as high levels of English language development, high levels of academic motivation and self-discipline, high levels of academic motivation based on high aspirations for life achievement, and a strong cultural belief in the empowering role of education in achieving these aspirations. School readiness also includes having the kinds of "intelligence" and learning styles that are consistent with standard schooling and standard models of academic instruction. This academic achievement gap is illustrated in Figure 1.

Figure 1

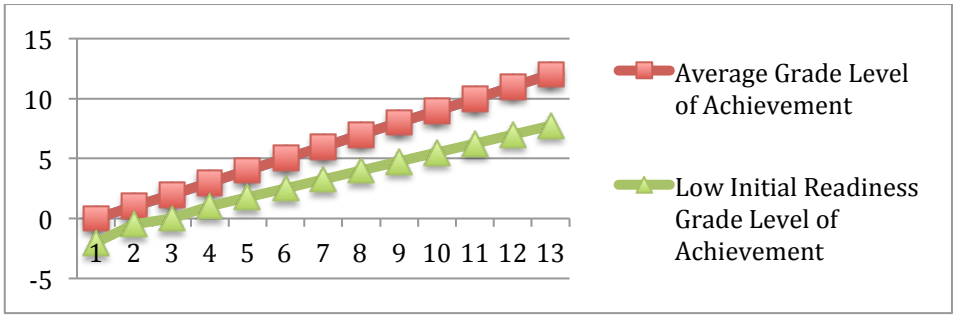

Figure 1. The Typical School Achievement Gap between Average and Low Initial Readiness Students

The central thesis of this article is that this outcome is driven fundamentally by three central structural elements—self-reinforcing causal feedback loops—one mainly between teachers and students around teacher expectations (Rist, 1972; Clauset & Gaynor, 1982), another between student performance in a school and the attractiveness of the school for high quality teachers (Betts, *et al.*, 2000;

Bonesrønning, *et al.*, 2005; Clotfelter, *et al.*, 2006; Lankford, *et al.*, 2002; Peske and Haycock, 2006), and the third between student performance and the level of school funding (Klein, 2007).

Figure 2

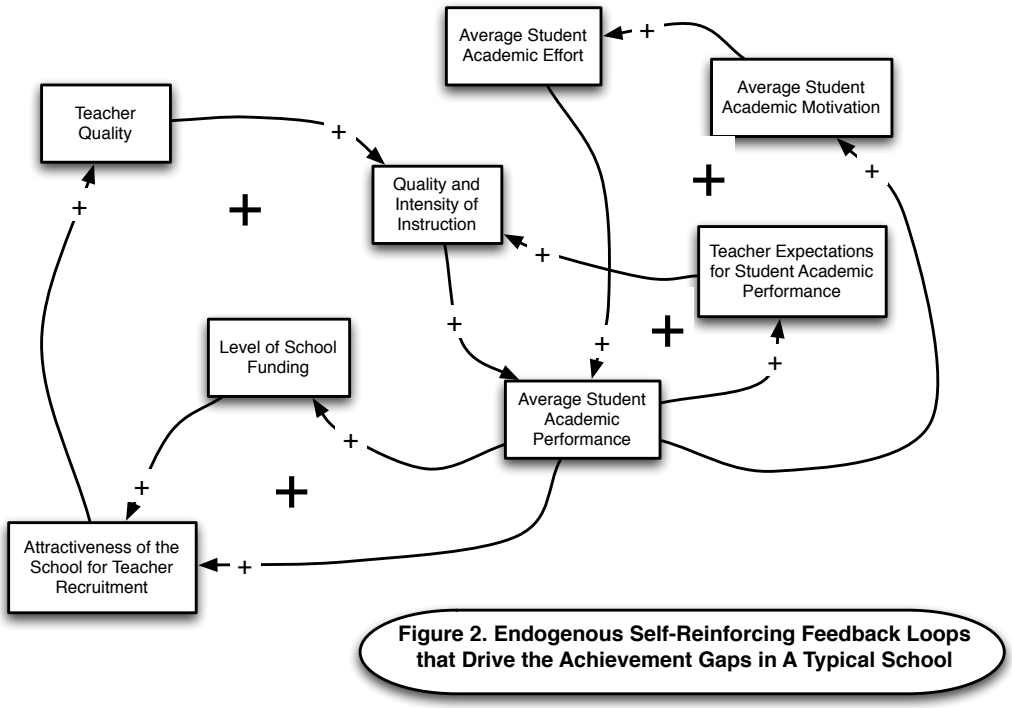

Figure 2. Endogenous Self-Reinforcing Feedback Loops that Drive the Achievement Gaps in A Typical School

I believe that it is precisely this dysfunctional feedback structure that must be changed if school reform is to succeed. In the following pages I present the results of several computer simulations that include the essential elements of a school—shown first as a causal-loop diagram (Figure 3) and then as a full-blown System Dynamics computer-simulation model (Figure 4).

Figure 3

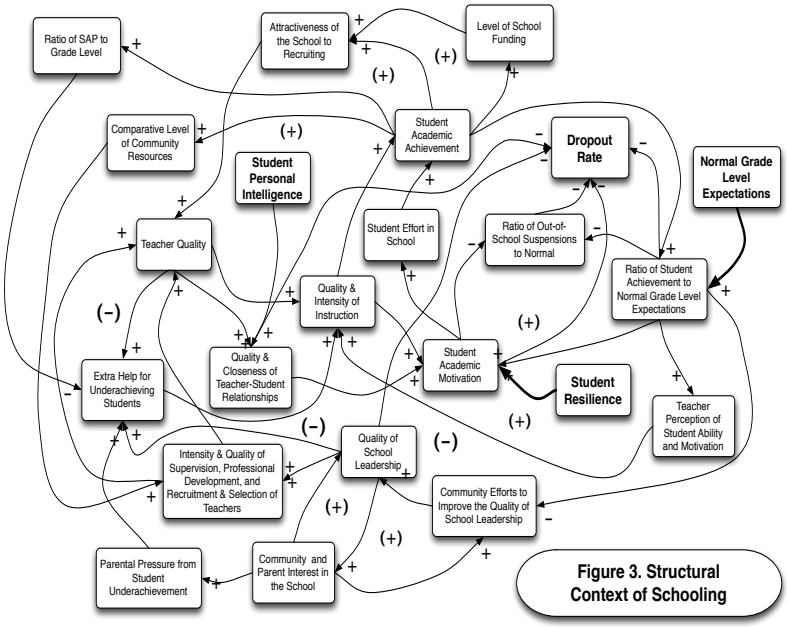

Figure 4

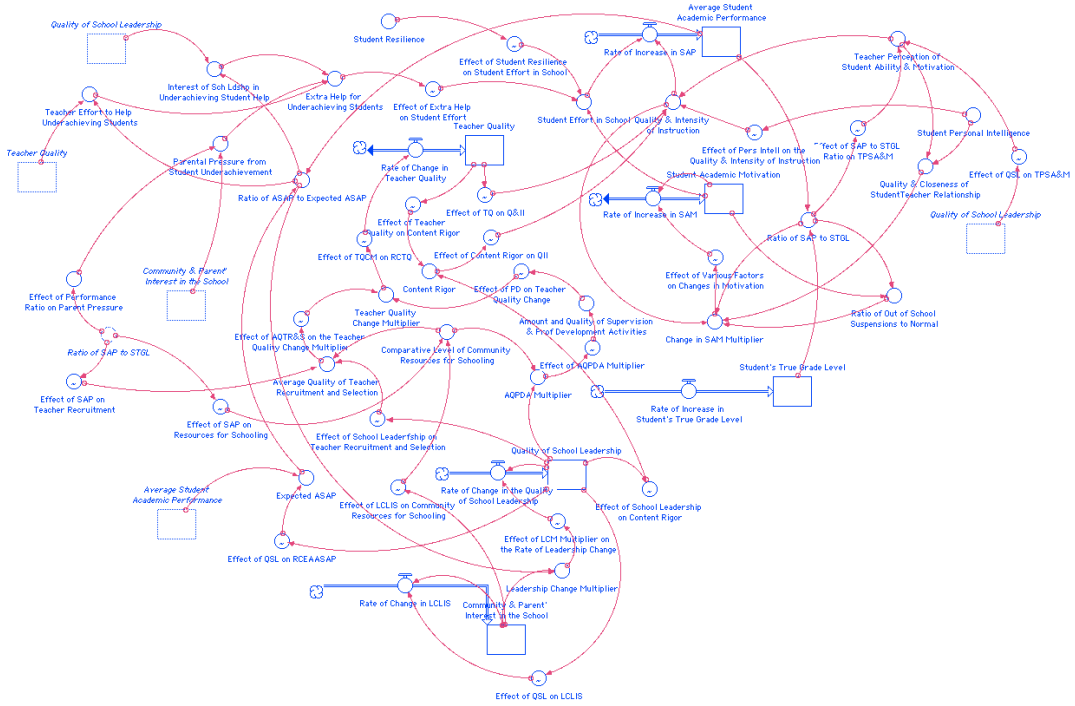

Figure 4. The School Simulation Model

These simulations first display the results of the basic model, described above and then examine the effects on the system of higher teacher quality, school leadership, and community-parent interest in the school. Finally, the effects are examined of student characteristics that are widely alleged to be important, especially for initially and traditionally low-achieving students: personal intelligence (Gardner, 2011; Goleman, 2006) and resilience (Allen, 2004; Brown, 2004; Carnes, 2009; Coleman, 2007; Crawford, 2006; Marshall, 2008; Nears, 2007; Salley, 2005). In all cases, for this article, the emphasis is on the effects of these changes on initially low-achieving students.

The equations and table functions that specify the model are displayed in Appendix I. Appendix II contains a listing of many of the non-school developmental factors that have been tied to differential academic achievement. Appendix III lists an extensive categorized bibliography of sources related to the factors listed in Appendix II.

RESULTS

The Basic Dynamics of a Typical School

The first set of simulation experiments tested the effects of the basic dynamics discussed earlier in this paper and illustrated in 1 that drive the problematic reference mode shown in Figure 2. In these runs, the only changes made are to the *initial* level of "Student Academic Performance" so as to represent these initial differences mathematically in the model. All other variables in the model are held constant with values that represent a typical school.

It should be pointed out at this point that student academic performance is shown in real physical units: the grade-level correspondence of the student's actual academic performance vs. the student's expected grade-level performance (i.e., the student's "true" (age-correspondent) grade level. Other variables in the model are shown as what is called "dimensionless." They are, in essence, scaled values, with "1" as the "normal" value and with higher and lower values showing proportionately greater and lesser values. Thus, in the basic simulation runs, the other variables all are initialized at "1." In subsequent runs "high" values of teacher quality, school leadership, student resilience, etc. are initialized as "1.2" whereas "low" values are initialized as "0.8."

The Effects of the Typical (Baseline) School on Students with Average Entry Characteristics

The graph (Figure 5) shows the typical progress of an initially average student over twelve years in a typical school. You can see that the student's academic progress tracks her or his age-grade-level.

Figure 5

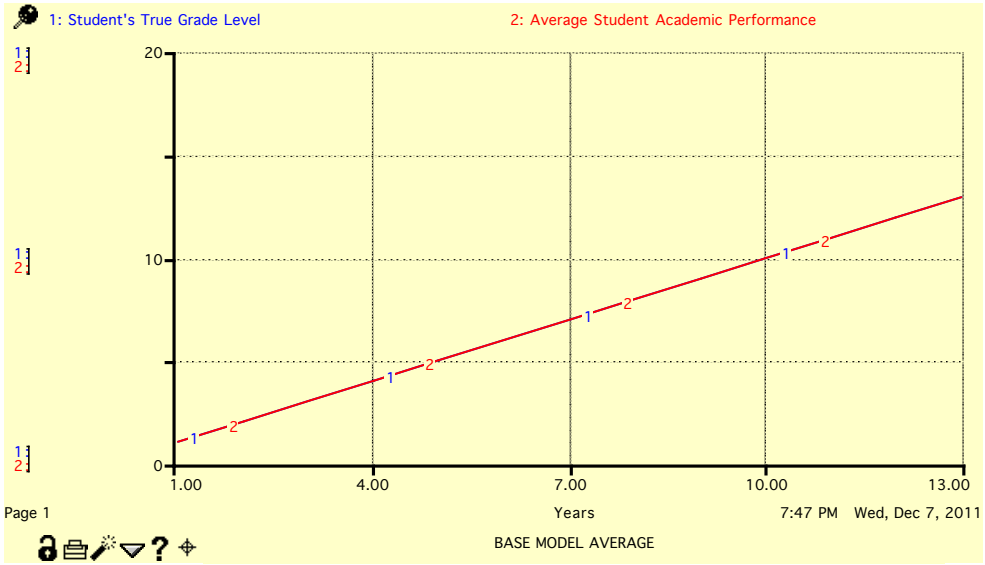

Figure 5. Model Output: The Academic Progress of an Initially Average Student in Comparison to Normal Grade-Level Progression in a Typical School

The Effects of the Typical (Baseline) School on Students with Above-Average Entry Characteristics

The graph (Figure 6) shows the typical progress of an initially above-average student over twelve years in a typical school. You can see that the student's academic progress tracks well above age-grade-level.

Figure 6

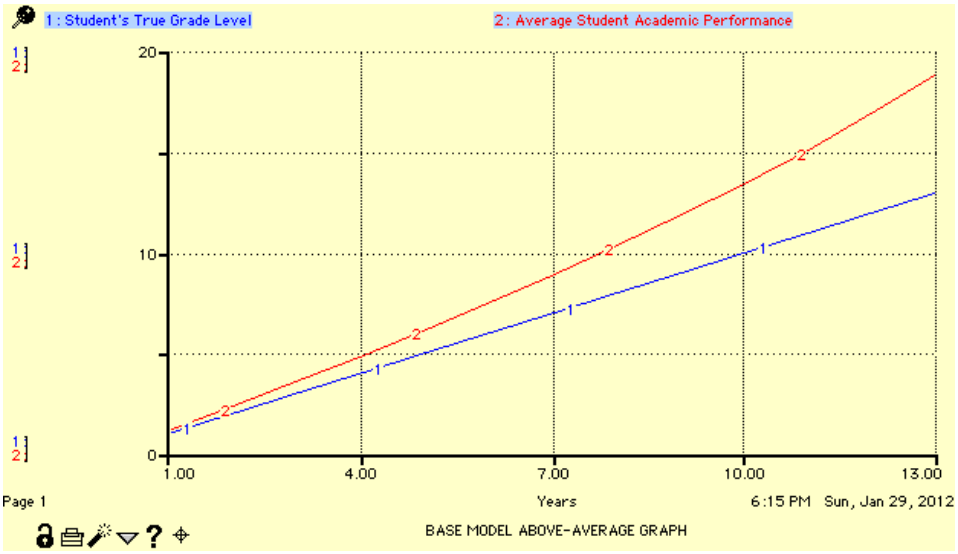

Figure 6. Model Output: The Academic Progress of an Initially Above-Average Student in Comparison to Normal Grade-Level Progression in a Typical School

The Effects of the Typical School on Students with Below-Average Entry Characteristics

The graph (Figure 7) shows the typical progress of an initially below-average student over twelve years as a student in a typical school. You can see that the student's academic progress lies consistently below that expected for her or his age-grade-level, which is the essence of the so-called "achievement gap."

Figure 7

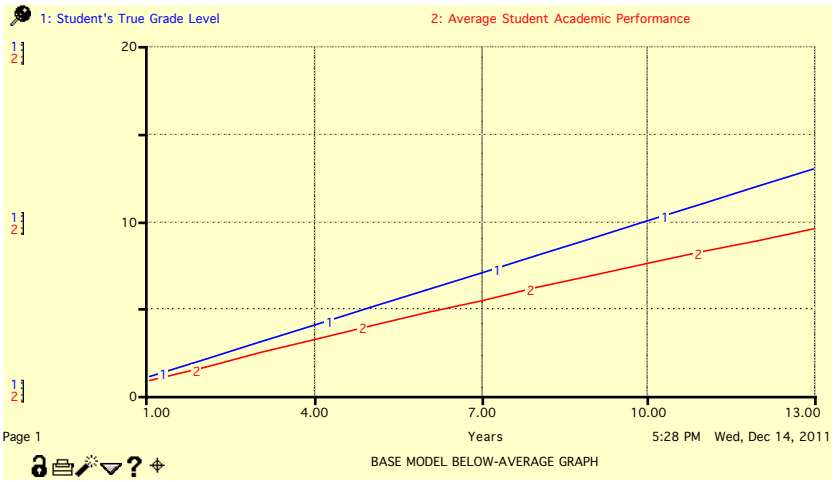

Figure 7. Model Output: The Academic Progress of an Initially Below-Average Student in Comparison to Normal Grade-Level Progression in a Typical School

TESTS OF EXPERIMENTAL EFFECTS

Tests were run to see—given the structure of the model and the theory of the structure of schooling represented in it—the effects of improvements in different elements of schooling on initially below-average students: high teacher quality; high level of school leadership; high level of interest in school on the part of parents and community leaders; combination of high teacher and school leadership quality; combination of high teacher quality and a high level of interest in school on the part of parents and community leaders; combination of a high level of school leadership and a high level of interest in school on the part of parents and community leaders; combination of high quality teaching, a high level of school leadership and a high level of interest in school on the part of parents and community leaders; a high level of student personal intelligence; and a high level of individual student resilience. These model effects are shown in a series of graphs (Figures 8-16).

Figure 8

Effects of High Teacher Quality on Initially Below-Average Students

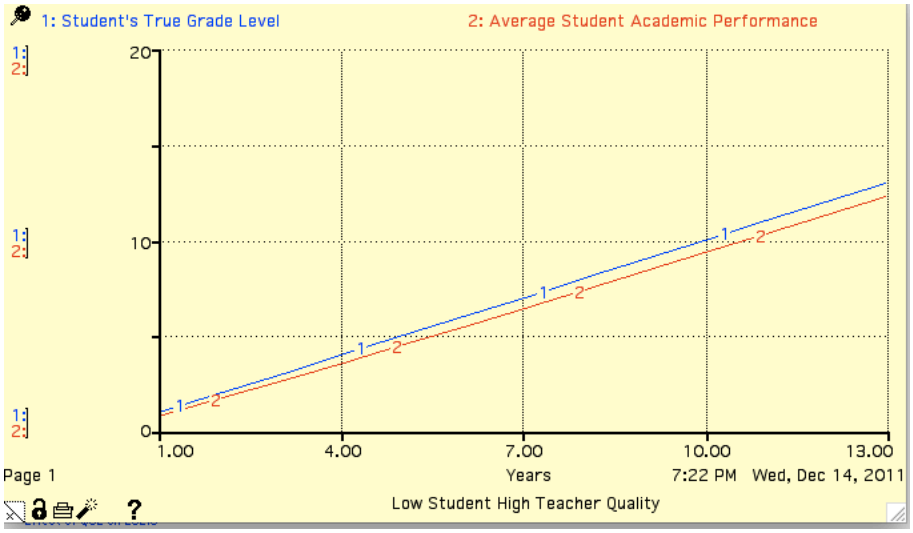

Figure 8. Effects of High Teacher Quality on Initially Below-Average Students

Figure 9

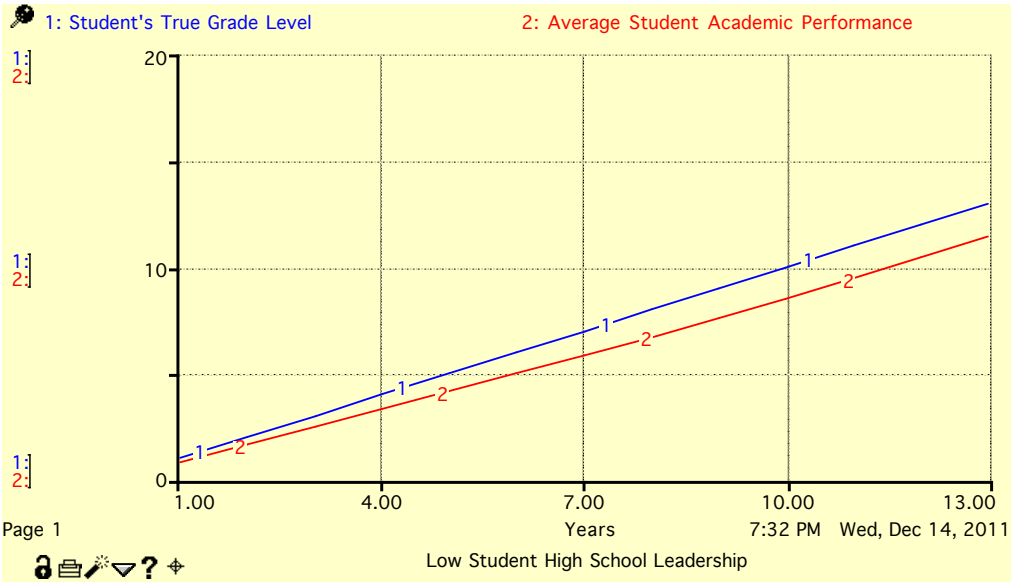

Figure 9. Effects of a High Level of School Leadership on Initially Below-Average Students

Figure 10

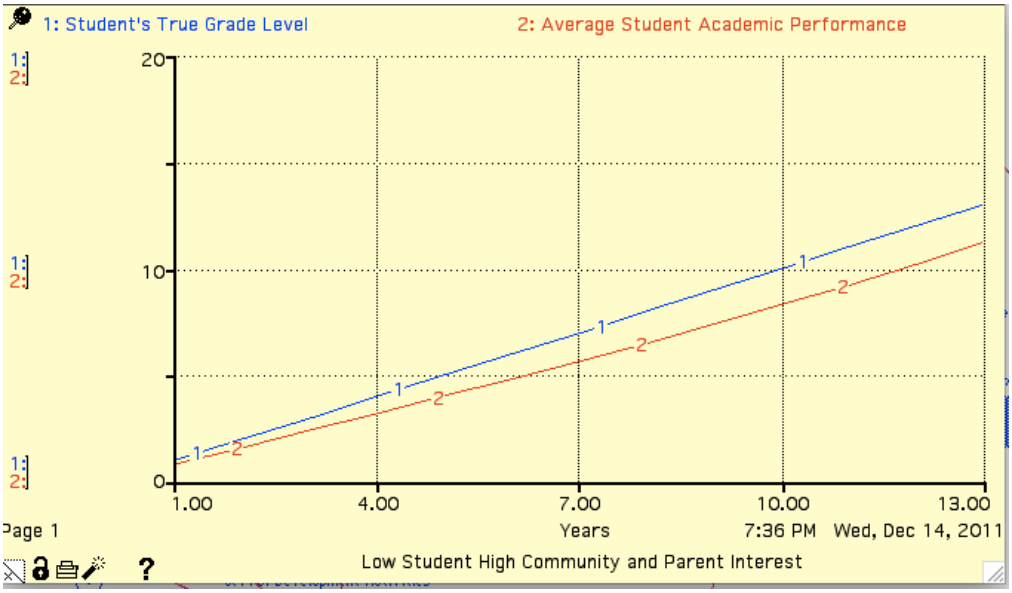

Figure 10. Effects of a High Level of Community and Parent Interest in School on Initially Below-Average Students

Figure 11

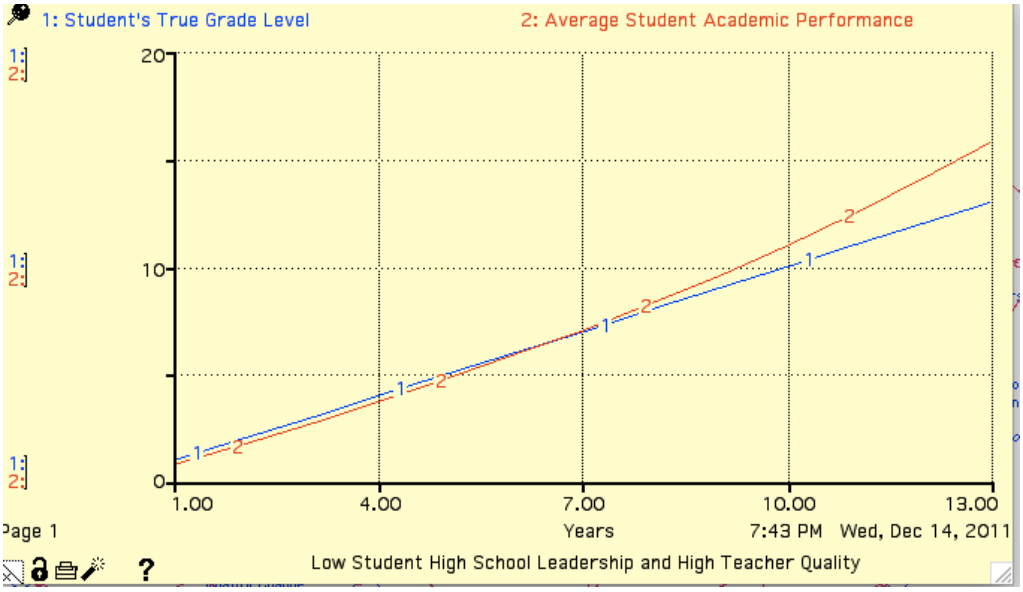

Figure 11. Effects of a High Combination of Teacher Quality and School Leadership on Initially Below-Average Students

Figure 12

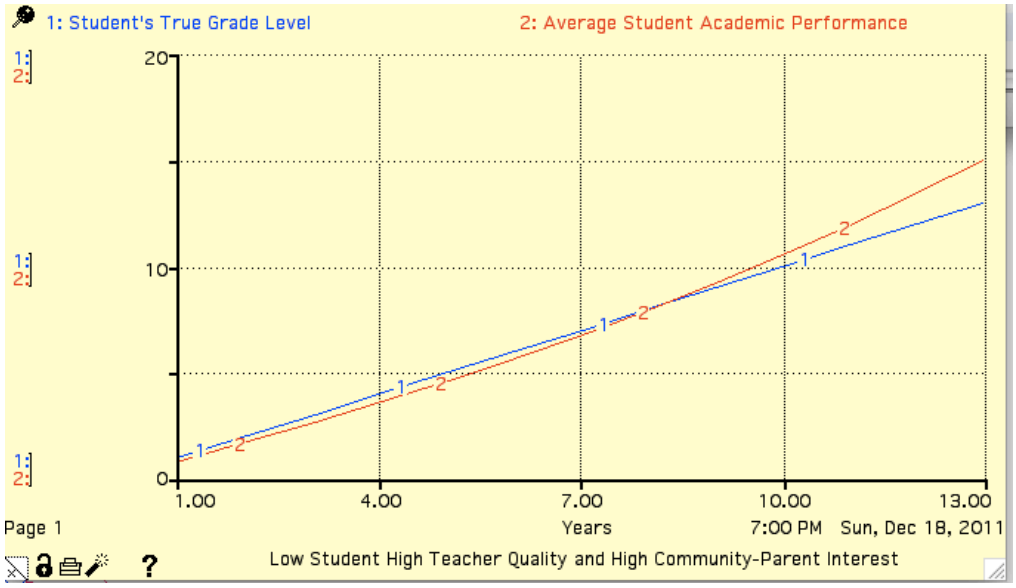

Figure 12. Effects of a High Combination of Teacher Quality and Community-Parent Interest on Initially Below-Average Students

Figure 13

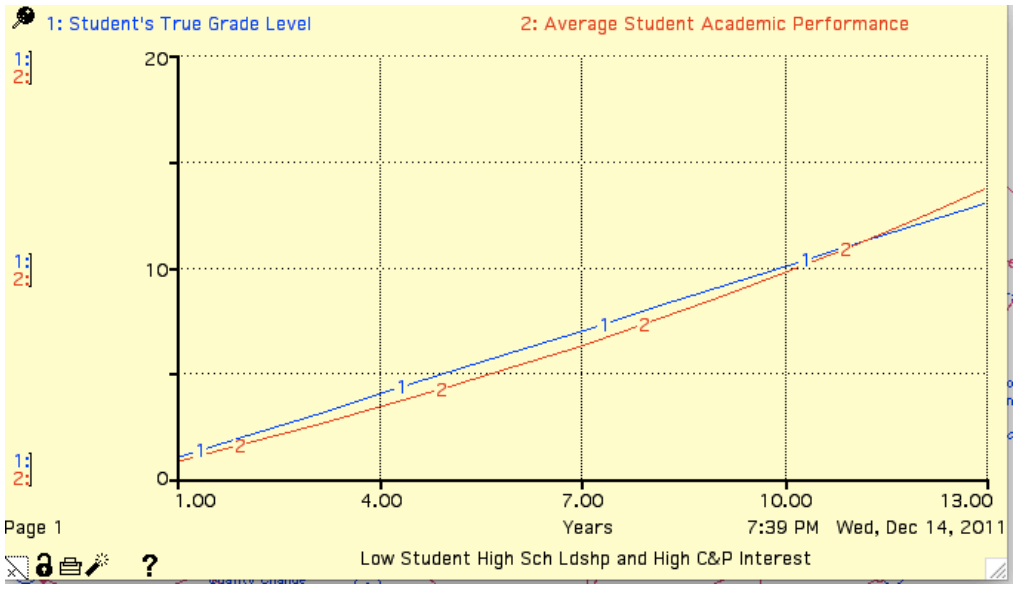

Figure 13. Effects of a High Combination of School Leadership and Community and Parent Interest in Schools on Initially Below-Average Students

Figure 14

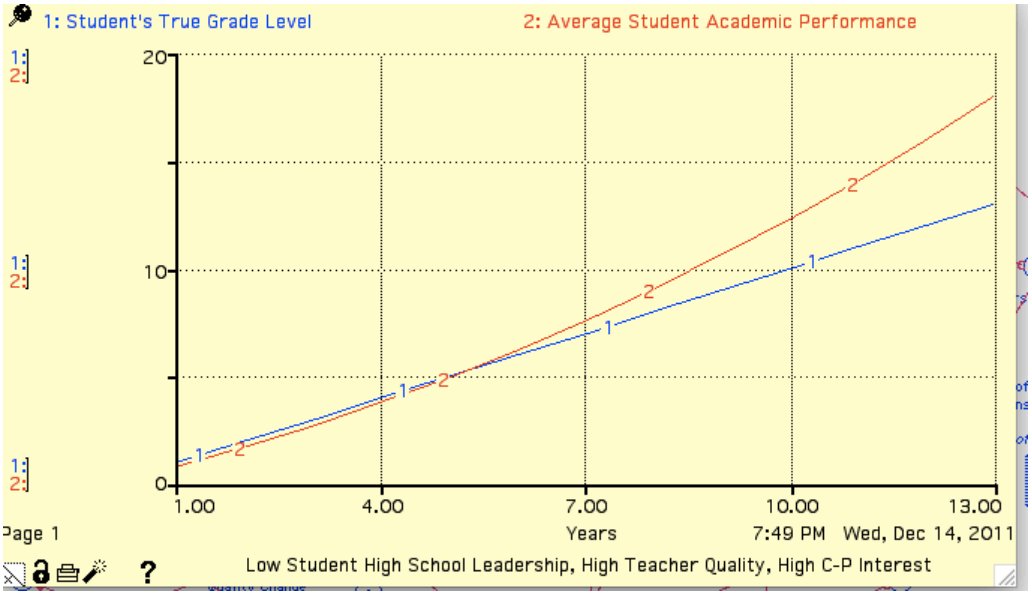

Figure 14. Effects of a High Combination of Teacher Quality, School Leadership, and Community Leader Interest on Initially Below-Average Students

Figure 15

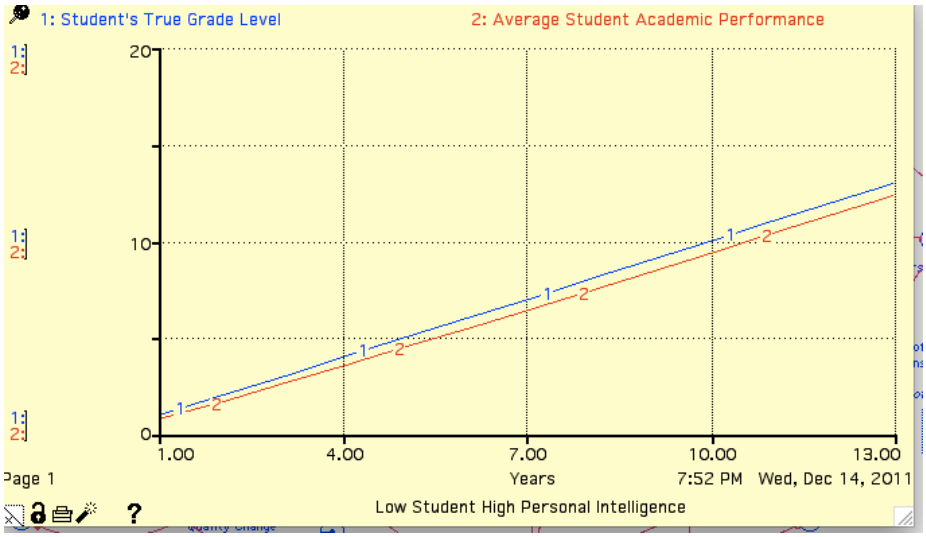

Figure 15. Effects of High Student Personal Intelligence on Initially Below-Average Students

Figure 16

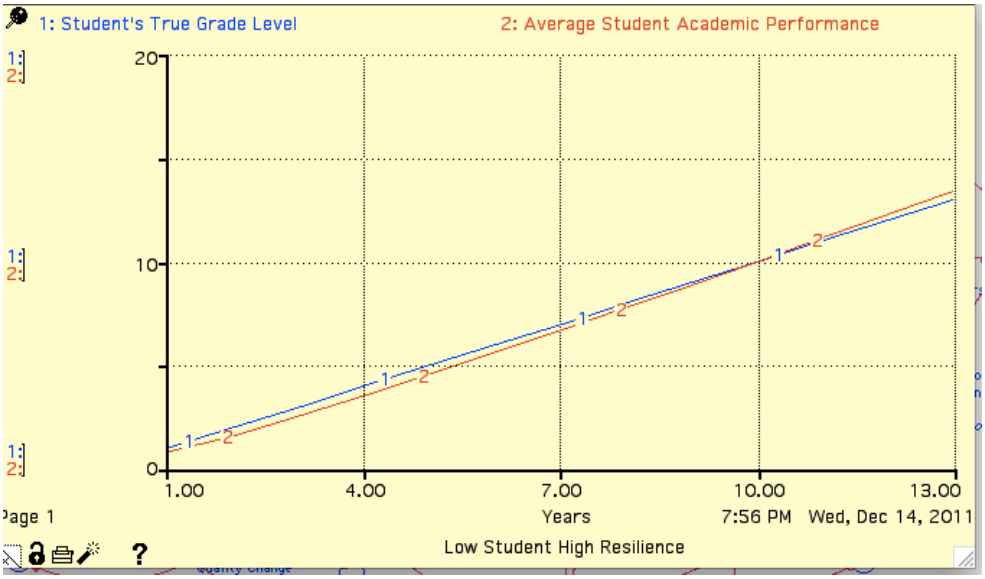

Figure 16. Effects of High Student Resilience on Initially Below-Average Students

CONCLUSIONS

Given the structure of the model as formulated, high teacher quality, school leadership, and community and parent interest in schools all have quite significant effects on the academic performance of initially low-achieving students, to the point of closing the gap with grade level standards. The combinations of pairs of these variables have even greater effects. The greatest effects are achieved by the combination of all three of these variables.

The effects of student personal intelligence and resilience were tested as well. It is important to note, however, that these variables are exogenous to the structure of the school, residing in the students as personal characteristics. However, they are

often mentioned as important characteristics, especially for initially low achieving students.

Student interpersonal intelligence is posited to influence positively both the closeness of teacher-student relationships, which, in turn, affects student motivation and work effort, and the quality and intensity of instruction, which has a positive impact upon academic performance directly as well as, indirectly, upon student motivation and work effort.

Student resilience is posited to have positive effects for low achieving students on their work effort, which affects their academic performance and, in turn, their motivation, teacher expectations, and further work effort. Both student interpersonal intelligence and resilience have positive effects on the achievement of initially low-achieving students, helping to bring their achievement up to average levels or beyond, at least given the theory described above of how they interact with other variables in the school.

IMPLICATIONS

Since the results presented are simulation results and, therefore, are theoretical, not empirical, the implications of these findings are twofold. First, to the extent that the structure of the model is viewed as sound—including the configuration of variables and causal interactions and the proposed "effect sizes" represented in the equations and table functions in Appendix I—the results confirm the importance of teacher quality and school leadership, especially together with the level of interest in schools of parents and the community.

While teacher quality in the model has slightly greater effects that school leadership, it seems important to keep in mind that changes in the overall level of teacher quality probably cannot be achieved in the real world without strong school leadership—through the effects of leadership on the recruitment and selection of teachers and on professional development, instructional supervision, and the rigor of the content presented, especially to low-achieving students. In the same way, community and parent interest in schools is probably essentially what in the world of research is called a fixed effect, amenable to deliberate strategic initiatives only in the long term—by improving the school incrementally over time, which, again in my view, seems crucially dependent on strong school leadership.

With this in mind, it seems that in the real world the most important variable amenable to purposeful policy action is school leadership. The implications for the selection, recruitment, and preparation of a pool of both high quality teachers and strong school leaders seem evident.

Second, the model provides a theoretical foundation for further empirical research. There is a need for a careful examination by scholars of the structure of the model to assess its validity as a representation of the critical interactions that affect student academic performance, for all students but particularly for initially low-performing students.

Finally, there is a need for experimental research to test for the empirical significance and size of the causal effects among the paired variables in the model, almost all of which are currently empirically unconfirmed. To put it another way,

each of the parameters in the model (Appendix I, *infra*, pp. 21-25) represents an object of potential experimental research.

Thus, the model lays out a potential research agenda for those interested in the existing socio-economic, racial, and ethnic achievement gaps.

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APPENDIX I: MODEL EQUATIONS AND TABLE FUNCTIONS

Average_Student_Academic_Performance(t) = Average_Student_Academic_Performance(t - dt) + (Rate_of_Increase_in_SAP) * dt

INIT Average_Student_Academic_Performance = .8

INFLOWS:

Rate_of_Increase_in_SAP = Quality_&_Intensity_of_Instruction*Student_Effort_in_School

Community_&_Parent'_Interest_in_the_School(t) = Community_&_Parent'_Interest_in_the_School(t - dt) + (Rate_of_Change_in_LCLIS) * dt

INIT Community_&_Parent'_Interest_in_the_School = 1

INFLOWS:

Rate_of_Change_in_LCLIS = Effect_of_QSL_on_LCLIS*Community_&_Parent'_Interest_in_the_School

Quality_of_School_Leadership(t) = Quality_of_School_Leadership(t - dt) + (Rate_of_Change_in_the_Quality_of_School_Leadership) * dt

INIT Quality_of_School_Leadership = 1

INFLOWS:

Rate_of_Change_in_the_Quality_of_School_Leadership = Effect_of_LCM_Multiplier_on_the_Rate_of_Leadership_Change*Quality_of_School_Leadership

Student's_True_Grade_Level(t) = Student's_True_Grade_Level(t - dt) + (Rate_of_Increase_in_Student's_True_Grade_Level) * dt

INIT Student's_True_Grade_Level = 1

INFLOWS:

Rate_of_Increase_in_Student's_True_Grade_Level = 1

Student_Academic_Motivation(t) = Student_Academic_Motivation(t - dt) + (Rate_of_Increase_in_SAM) * dt

INIT Student_Academic_Motivation = 1

INFLOWS:

Rate_of_Increase_in_SAM = Student_Academic_Motivation*Effect_of_Various_Factors_on_Changes_in_Motivation

Teacher_Quality(t) = Teacher_Quality(t - dt) + (Rate_of_Change_in_Teacher_Quality) * dt

INIT Teacher_Quality = 1

INFLOWS:

Rate_of_Change_in_Teacher_Quality = Effect_of_TQCM_on_RCTQ/DELAY(3,0)

Amount_and_Quality_of_Supervision_&_Prof_Development_Activities = Effect_of_AQPDA_Multiplier

AQPDA_Multiplier = Comparative_Level_of_Community_Resources_for_Schooling*Quality_of_School_Leadership

Average_Quality_of_Teacher_Recruitment_and_Selection = Comparative_Level_of_Community_Resources_for_Schooling*Effect_of_School_Leaderfship_on_Teacher_Recruitment_and_Selection*Effect_of_SAP_on_Teacher_Recruitment

Change_in_SAM_Multiplier = (Quality_&_Closeness_of_StudentTeacher_Relationship+Quality_&_Intensity_of_Instruction+1/Ratio_of_Out_of_School_Suspensions_to_Normal+Ratio_of_SAP_to_STGL)/4

Comparative_Level_of_Community_Resources_for_Schooling = Effect_of_LCLIS_on_Community_Resources_for_Schooling

content_rigor = Effect_of_School_Leadership_on_Content_Rigor*Effect_of_Teacher_Quality_on_Content_Rigor

Effect_of_Performance_Ratio_on_Parent_Pressure = IF(Ratio_of_SAP_to_STGL<1)THEN(1/Ratio_of_SAP_to_STGL)ELSE(1)

Expected_ASAP = Average_Student_Academic_Performance*Effect_of_QSL_on_RCEAASAP

Extra_Help_for_Underachieving_Students = Interest_of_Sch_Ldshp_in_Underachieving_Student_Help*Teacher_Effort_to_Help_Underachieving_Students*Parental_Pressure_from_Student_Underachievement

Interest_of_Sch_Ldshp_in_Underachieving_Student_Help = IF(Quality_of_School_Leadership)>1.15THEN(1/Ratio_of_ASAP_to_Expected_ASAP)ELSE(1)

Leadership_Change_Multiplier = Community_&_Parent'_Interest_in_the_School*(1/Ratio_of_ASAP_to_Expected_ASAP)

Parental_Pressure_from_Student_Underachievement = IF(Community_&_Parent'_Interest_in_the_School>1.5)THEN(Effect_of_Performance_Ratio_on_Parent_Pressure)ELSE(1)

Quality_&_Closeness_of_StudentTeacher_Relationship = Student_Personal_Intelligence*Teacher_Perception_of_Student_Ability_&_Motivation

Quality_&_Intensity_of_Instruction = Effect_of_TQ_on_Q&II*Teacher_Perception_of_Student_Ability_&_Motivation*Effect_of_Pers_Intell_on_the_Quality_&_Intensity_of_Instruction*Effect_of_Content_Rigor_on_QII

Ratio_of_ASAP_to_Expected_ASAP = Average_Student_Academic_Performance/Expected_ASAP

Ratio_of_Out_of_School_Suspensions_to_Normal = (1/Student_Academic_Motivation)*1/Ratio_of_SAP_to_STGL

Ratio_of_SAP_to_STGL = Average_Student_Academic_Performance/Student's_True_Grade_Level

Student_Effort_in_School = IF(Student_Academic_Motivation=1OR(Student_Academic_Motivation>1))THEN(Student_Academic_Motivation*Effect_of_Extra_Help_on_Student_Effort)ELSE(Student_Academic_Motivation*Effect_of_Extra_Help_on_Student_Effort*Effect_of_Student_Resilience_on_Student_Effort_in_School)

Student_Personal_Intelligence = 1

Student_Resilience = 1.2

Teacher_Effort_to_Help_Underachieving_Students = IF(Teacher_Quality>1.5)THEN(1/Ratio_of_ASAP_to_Expected_ASAP)ELSE(1)

Teacher_Perception_of_Student_Ability_&_Motivation = Effect_of_SAP_to_STGL_Ratio_on_TPSA&M*Effect_of_QSL_on_TPSA&M

Teacher_Quality_Change_Multiplier = Effect_of_AQTR&S_on_the_Teacher_Quality_Change_Multiplier*Effect_of_PD_on_Teacher_Quality_Change

Effect_of_AQPDA_Multiplier = GRAPH(AQPDA_Multiplier)

(0.5, 0.85), (0.6, 0.88), (0.7, 0.9), (0.8, 0.95), (0.9, 0.98), (1, 1.00), (1.10, 1.00), (1.20, 1.05), (1.30, 1.10), (1.40, 1.15), (1.50, 1.20)

Effect_of_AQTR&S_on_the_Teacher_Quality_Change_Multiplier = GRAPH(Average_Quality_of_Teacher_Recruitment_and_Selection)

(0.5, 0.875), (0.6, 0.9), (0.7, 0.925), (0.8, 0.95), (0.9, 0.975), (1, 1.00), (1.10, 1.00), (1.20, 1.01), (1.30, 1.01), (1.40, 1.02), (1.50, 1.02)

Effect_of_Content_Rigor_on_QII = GRAPH(content_rigor)

(0.5, 0.755), (0.6, 0.85), (0.7, 0.855), (0.8, 0.95), (0.9, 0.955), (1, 1.00), (1.10, 1.01), (1.20, 1.01), (1.30, 1.02), (1.40, 1.02), (1.50, 1.03)

Effect_of_Extra_Help_on_Student_Effort = GRAPH(Extra_Help_for_Underachieving_Students)

(0.5, 1.00), (0.6, 1.00), (0.7, 1.00), (0.8, 1.00), (0.9, 1.00), (1, 1.00), (1.10, 1.03), (1.20, 1.06), (1.30, 1.09), (1.40, 1.12), (1.50, 1.15)

Effect_of_LCLIS_on_Community_Resources_for_Schooling = GRAPH(Community_&_Parent'_Interest_in_the_School)

(0.5, 1.00), (0.6, 1.00), (0.7, 1.00), (0.8, 1.00), (0.9, 1.00), (1, 1.00), (1.10, 1.03), (1.20, 1.06), (1.30, 1.09), (1.40, 1.12), (1.50, 1.15)

Effect_of_LCM_Multiplier_on_the_Rate_of_Leadership_Change = GRAPH(Leadership_Change_Multiplier)

(0.00, -0.08), (0.167, -0.07), (0.333, -0.06), (0.5, -0.0575), (0.667, -0.055), (0.833, -0.05), (1, 0.00), (1.17, 0.05), (1.33, 0.075), (1.50, 0.1)

Effect_of_PD_on_Teacher_Quality_Change = GRAPH(Amount_and_Quality_of_Supervision_&_Prof_Development_Activities)

(0.5, 0.875), (0.6, 0.9), (0.7, 0.925), (0.8, 0.95), (0.9, 0.975), (1, 1.00), (1.10, 1.00), (1.20, 1.01), (1.30, 1.01), (1.40, 1.02), (1.50, 1.02)

Effect_of_Pers_Intell_on_the_Quality_&_Intensity_of_Instruction = GRAPH(Student_Personal_Intelligence)

(0.5, 0.75), (0.6, 0.8), (0.7, 0.85), (0.8, 0.9), (0.9, 0.95), (1, 1.00), (1.10, 1.05), (1.20, 1.10), (1.30, 1.15), (1.40, 1.20), (1.50, 1.25)

Effect_of_QSL_on_LCLIS = GRAPH(Quality_of_School_Leadership)

(0.00, 0.1), (0.167, 0.075), (0.333, 0.05), (0.5, -0.01), (0.667, -0.02), (0.833, -0.01), (1, 0.00), (1.17, 0.02), (1.33, 0.025), (1.50, 0.03)

Effect_of_QSL_on_RCEAASAP = GRAPH(Quality_of_School_Leadership)

(0.00, 1.00), (0.167, 1.00), (0.333, 1.00), (0.5, 1.00), (0.667, 1.00), (0.833, 1.00), (1, 1.00), (1.17, 1.01), (1.33, 1.01), (1.50, 1.02)

Effect_of_QSL_on_TPSA&M = GRAPH(Quality_of_School_Leadership)

(0.5, 1.00), (0.6, 1.00), (0.7, 1.00), (0.8, 1.00), (0.9, 1.00), (1, 1.00), (1.10, 1.01), (1.20, 1.03), (1.30, 1.04), (1.40, 1.06), (1.50, 1.07)

Effect_of_SAP_on_Teacher_Recruitment = GRAPH(Ratio_of_SAP_to_STGL)

(0.5, 0.9), (0.6, 0.92), (0.7, 0.94), (0.8, 0.96), (0.9, 0.98), (1, 1.00), (1.10, 1.02), (1.20, 1.04), (1.30, 1.06), (1.40, 1.08), (1.50, 1.10)

Effect_of_SAP_to_STGL_Ratio_on_TPSA&M = GRAPH(Ratio_of_SAP_to_STGL)

(0.5, 0.5), (0.6, 0.6), (0.7, 0.7), (0.8, 0.8), (0.9, 0.9), (1, 1.00), (1.10, 1.10), (1.20, 1.20), (1.30, 1.30), (1.40, 1.40), (1.50, 1.50)

Effect_of_School_Leaderfship_on_Teacher_Recruitment_and_Selection = GRAPH(Quality_of_School_Leadership)

(0.5, 0.85), (0.6, 0.88), (0.7, 0.91), (0.8, 0.94), (0.9, 0.97), (1, 1.00), (1.10, 1.03), (1.20, 1.06), (1.30, 1.09), (1.40, 1.12), (1.50, 1.15)

Effect_of_School_Leadership_on_Content_Rigor = GRAPH(Quality_of_School_Leadership)

(0.5, 0.875), (0.6, 0.9), (0.7, 0.925), (0.8, 0.95), (0.9, 0.975), (1, 1.00), (1.10, 1.02), (1.20, 1.05), (1.30, 1.07), (1.40, 1.10), (1.50, 1.12)

Effect_of_Student_Resilience_on_Student_Effort_in_School = GRAPH(Student_Resilience)

(0.5, 0.75), (0.6, 0.8), (0.7, 0.85), (0.8, 0.9), (0.9, 0.95), (1, 1.00), (1.10, 1.10), (1.20, 1.20), (1.30, 1.30), (1.40, 1.40), (1.50, 1.50)

Effect_of_Teacher_Quality_on_Content_Rigor = GRAPH(Teacher_Quality)

(0.5, 0.875), (0.6, 0.9), (0.7, 0.925), (0.8, 0.95), (0.9, 0.975), (1, 1.00), (1.10, 1.02), (1.20, 1.05), (1.30, 1.07), (1.40, 1.10), (1.50, 1.12)

Effect_of_TQCM_on_RCTQ = GRAPH(Teacher_Quality_Change_Multiplier)

(0.5, -0.3), (0.6, -0.15), (0.7, -0.1), (0.8, -0.06), (0.9, -0.03), (1, 0.00), (1.10, 1.00), (1.20, 1.00), (1.30, 1.01), (1.40, 1.01), (1.50, 1.01)

Effect_of_TQ_on_Q&II = GRAPH(Teacher_Quality)

(0.5, 0.955), (0.6, 0.96), (0.7, 0.965), (0.8, 0.97), (0.9, 0.975), (1, 1.00), (1.10, 1.05), (1.20, 1.10), (1.30, 1.15), (1.40, 1.20), (1.50, 1.25)

Effect_of_Various_Factors_on_Changes_in_Motivation = GRAPH(Change_in_SAM_Multiplier)

(0.00, -0.025), (0.167, -0.025), (0.333, -0.02), (0.5, -0.02), (0.667, -0.015), (0.833, -0.01), (1, 0.00), (1.17, 0.01), (1.33, 0.02), (1.50, 0.03)

APPENDIX II: FACTORS AFFECTING DIFFERENTIAL STUDENT ACHIEVEMENT

- Family wealth
- Family education
- Family nutrition
- Family health care
- Pre-natal nutrition
- Pre-natal health care
- Pre-natal maternal trauma
- Early childhood nutrition
- Early childhood health care
- Parenting practice

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