

# Development Toward School Readiness: A Holistic Model

by Alan Kibbe Gaynor

## *Abstract*

This paper describes a systemic analysis of the early childhood development factors that explain the variance in readiness for school among representative five-year-olds in the United States.<sup>1</sup> The model expresses a theory that incorporates a broad set of causally interactive endogenous variables that are hypothesized to be driven by three exogenous variables: parental educational attainment; racial/ethnic status; and single parent/divorced/remarried vs. stable marriage family status.

The model was run in computer simulation mode. The results seem compatible with what is known about school readiness patterns. While this finding doesn't prove the validity of the model, it at least makes it seem reasonable as a multi-variate, systemic description of the state of affairs that determines readiness for school at the age of five and that provides a reasonable explanation for the variance in school readiness among five-year-olds.

Finally, the model was run in experimental computer simulation mode to evaluate the likely effects of five interventions: a set of cognitive and academic interventions; interventions related to health care and nutrition; income-related interventions; interventions related to reducing the effect of low income on family stress; and a combination of all these types of interventions. These interventions were simulated by modifying the

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<sup>1</sup> School readiness is a complex concept that, overall, relates to a child's readiness at age five to learn in a school environment. Julia Isaacs ("Starting School at a Disadvantage: The School Readiness of Poor Children," Brookings Institute, Center on Children and Families, March 2012) defines school readiness, and the relative disadvantage of poor children in this regard, in the following terms:

Poor children start school at a disadvantage. Their health, behaviors, and skills make them less prepared for kindergarten than children growing up under better economic conditions. Fewer than half (48 percent) of poor children are school ready at age five, under a summary measure that encompasses early math and reading skills, learning-related and problem behaviors, and overall physical health. Children born to parents with moderate or higher incomes are much more likely to enter school ready to learn; three-fourths (75 percent) of these children are ready for school at age five. In other words, there is a 27 percentage point gap in school readiness between poor children and those from moderate or higher income families.

structure of the model to moderate the effects of low parental education and low income on other key variables in the early childhood development system..

As expected, combining cognitive and academic interventions, health and nutrition interventions, and family stress interventions with straightforward increases in low family income had a very substantial effect on the relative age of school readiness of children of parents with very low educational attainment (from a relative age of 2.9 years to a relative age of 4.3 years)—with very modest improvements in school readiness for children with parents who did not graduate from college. Of course, such a set of comprehensive interventions would be very costly and, probably, politically infeasible.

At least theoretically in the model, the more limited, and less costly, interventions vary in their likely effectiveness. Those dealing with income and family stress seem theoretically to be potentially the most effectiveness, with cognitive and academic interventions following. The least effective interventions, at least according to the model, are those that affect health and nutrition.

While the exercise was theoretical in nature—a kind of thought experiment—it is generally consistent with the literature on school readiness and early childhood development and yet, at the same time emphasizes the weaknesses in the current knowledge base. Most of the research available on the development of readiness for school is correlational in nature. What is needed—although it is difficult to do—is bivariate experimental research that would provide the effect sizes that are needed for more precise systemic analysis.

### *Introduction*

In the last few years I formulated a computer simulation model presenting a theory of the dynamics of schooling<sup>2</sup> that, in the typical case, reinforce children's initial readiness for school. Additional work with the model examined policies to alter the dynamics that characterize typical schools, dynamics that for the most part act—over children's entire time in school—to reinforce differences in initial readiness for school. That is, in the typical

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<sup>2</sup> Gaynor, Alan Kibbe (2011-2012). Different Kids—How Typical Schools Are Built to Fail and Need to Change: A Structural Analysis. Boston University *Journal of Education*, Vol. 192, Numbers 2-3, 13-27; Gaynor, Alan Kibbe (2011-2012). A Reflection on the Structural Analysis and the Case Study, Boston University *Journal of Education*, Vol. 192, Numbers 2-3, 31-32; Gaynor, Alan (2012) STELLA® Model Indicates Strong School Leadership is Central to Closing Achievement Gap, *The Connector*, isee Systems, Summer; Gaynor, Alan Kibbe (2012). The Racial, Ethnic, and Social Class Achievement Gaps: A Systems Analysis. *International Education Studies*, 5(1), February.

school, children who enter with low readiness do progressively worse in the course of their schooling in comparison to students who enter with average readiness—and far worse in comparison to students who enter school with high levels of readiness.

The major conclusion was that strong school leadership was critical to improving key system variables such as teacher quality, the rigorousness of the curriculum for all students, the professional development of teachers, and special programs to increase the academic ability and achievement of low-achieving students. Other important variables strongly influenced by school leadership are careful teacher supervision, building and maintaining community support for the school, and improving and maintaining family support for student aspirations, self-expectations, and academic skills. Of course, school district leadership plays an important role in the selection of school principals and in giving them freedom to act; however, this particular model focused on the dynamics of education at the school level, not at the school district level. For this analytic exercise, the school district (and the school superintendent) remained implicitly in the background.

However, a key finding was that while these changes in schooling were effective in bringing students with initially low readiness closer to *national norms*,<sup>3</sup> they were not effective in closing the gap between these students and average and high readiness students in the “good” school, itself. This was because in good schools the achievement of initially average and high readiness students also improves, thus maintaining the gap between these students and initially low achieving students.

Although I think that this computer simulation modeling effort produced important insights into the dynamics of schooling and their effects on the academic achievement of students with different levels of readiness for school, I asked myself the same question many others have asked themselves: Why do five-year-olds arrive in school with differential levels of readiness?

We know that they do. For example, the report of the Center on Children and Families cited earlier<sup>4</sup> says the following:

Fewer than half (48 percent) of poor children compared to 75 percent of children from moderate or high income households are ready for school at age five, resulting in a 27 percentage point gap in school readiness, as shown in Figure 1.

This comparison focuses on the difference between children from households with income below 100 percent of poverty (\$18,000 for a family of three or \$23,000 for a family of four, in 2011 terms) and

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<sup>3</sup> Measured, for example, by scores on high-stakes standardized tests in language arts, math, and science.

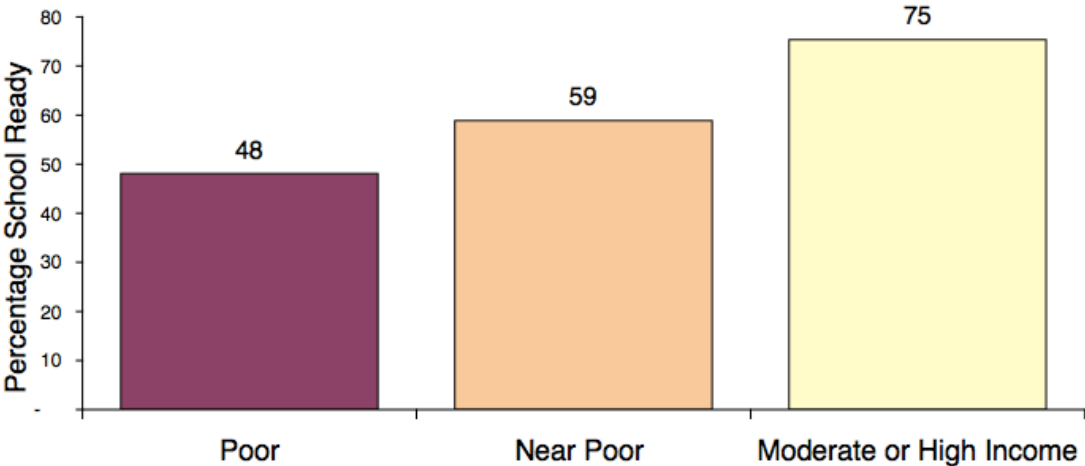
<sup>4</sup> Isaacs, Julia B. (*op. cit.*).

children from households with income above 185 percent of poverty. This latter group spans a broad spectrum of family income from incomes just above 185 percent of poverty (\$33,000 for a family of three in 2011) to much higher levels of family income.

Children who are “near poor” (from households with income between 100 and 185 percent of poverty) also enter kindergarten at a disadvantage, although faring better than poor children: 59 percent of children with incomes just above the poverty line are ready for school at age five.

School readiness rises to 86 percent of the children born into households with income above \$100,000, and falls to 42 percent for children who are persistently poor not just at birth, but also at ages two, four and five years (Isaacs and Magnuson, 2011).

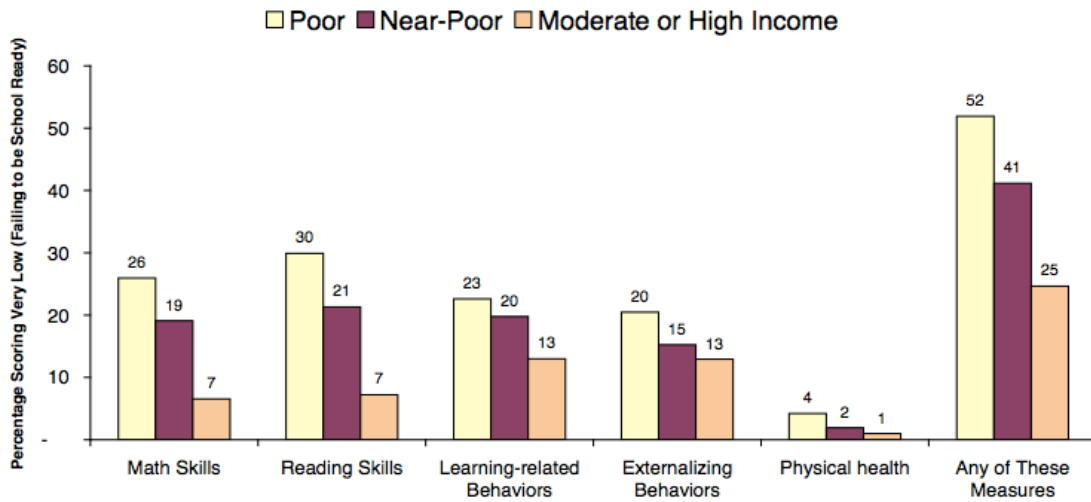
**Figure 1: Likelihood of Being Ready for School at Age Five, by Poverty Status at Birth**



The relationship between family income and school readiness is made even sharper in Figure 3 (below). Students from poor families are seen to be dramatically more probably below students from moderate or high-income families on a range of particular readiness measures—cognitive and behavioral.<sup>5</sup>

<sup>5</sup> *Ibid*, p. 4.

**Figure 2: Likelihood of Scoring Very Low (Failing to Be School Ready) on Measures of School Readiness, by Poverty Status**



Source and Notes: Brookings tabulations of data from the Early Childhood Longitudinal Study - Birth Cohort (ECLS-B). Very low is defined as more than one standard deviation below average on the academic and behavioral measures and in poor/fair health on the physical health measure.

This relationship can be seen as even more compelling when we place it in the context of the rising proportion of poor children in school:

For the first time in at least 50 years, a majority of U.S. public school students come from low-income families, according to a new analysis of 2013 federal data, a statistic that has profound implications for the nation. (Layton, L., "Majority of U.S. Public School Students Are in Poverty," *Washington Post*, January 16, 2015, <http://www.washingtonpost.com/people/lyndsey-layton>.)

This led me to build a computer simulation model and to do an analysis—based on the relevant literature—of the dynamics of early childhood development. In the end, I was interested in the implications of this analysis for policies of intervention that would help to lower the variance in the distribution of school readiness among five-year-olds by increasing the school readiness of children raised in low-income families whose parents had attained relatively low levels of education.

I am certainly not the only person interested in this question; however, I thought that a computer simulation modeling approach would provide a more holistic view of early childhood development than the approaches taken by the vast majority of other educational researchers. As illustrated in the reports cited above (and below), most of the research on the root causes of low school readiness (and on its long-term effects) focus on individual factors and on correlational research. The work reported in this paper (and in my previous work on school dynamics)—on the contrary—posits a set of *causal interactions* that seek to *explain* the correlations put forward in the literature.

As noted by a consortium of seventeen states that addressed the problem of school readiness about a decade ago, school readiness is of great importance:

Children who enter school not yet ready to learn, whether because of academic or social and emotional deficits, continue to have difficulties later in life. For example, children who score poorly on tests of cognitive skills during their preschool years are likely to do less well in elementary and high school than their higher-performing preschool peers and are more likely to become teen parents, engage in criminal activities, and suffer from depression. Ultimately, these children attain less education and are more likely to be unemployed in adulthood.<sup>6</sup>

Research by the UCD Geary Institute also speaks to the importance of school readiness. A report by Sarah Finnegan<sup>7</sup> identifies six lifelong effects of school readiness. The report argues that school readiness is important across multiple domains of development:

- Academic Achievement (Heckman, 2006)
- Peer Relationships (Ladd, 1999)
- Psychological Well Being (Alloy et. al, 1999)
- Teenage Pregnancy (Brooks-Gunn, 2003)
- Employment & Earnings (Raver, 2003)
- Criminal Activity (Le et al., 2006)<sup>8</sup>

A report from the RAND Corporation (2005) confirms the importance of school readiness in terms of long-term effects:<sup>9</sup>

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<sup>6</sup> School Readiness: Closing Racial and Ethnic Gaps, *Future of Children*, 15(1), Spring 2005, 6.

<sup>7</sup> Finnegan, Sarah (n.d.). Differential Teacher and Parent Ratings of School Readiness in a Disadvantaged Community, PFL Evaluation Team, Geary Institute, University College, Dublin, Ireland.

<sup>8</sup> Heckman, J. (2000), Invest in the very young. Chicago, IL: Ounce of Prevention Fund; Ladd, G.W. (1999). Peer relationships and social competence during early and middle childhood. *Annual Review of Psychology*, 50, 333-359; Brooks-Gunn, J. (2003). Do you believe in magic? *Social Policy Report*, 17 (1), 3-16; Raver, C. Cybele (2003). Does Work Pay Psychologically as Well as Economically? The Role of Employment in Predicting Depressive Symptoms and Parenting Among Low Income Families, *Child Development* (74(6), pp. 1720-1736, November.

<sup>9</sup> RAND Corporation (2005). Children at Risk: Consequences for School Readiness and Beyond, 4.

... Many children from disadvantaged backgrounds fail to meet grade-level expectations on core subjects. For example, national educational assessments at grades 8 and 12 show that about 50 percent of children from at-risk backgrounds (e.g., low parental education or low family income) score below the “basic” level of reading and math achievement, indicating that they have less than partial mastery of the knowledge and skills “fundamental for proficient work” at that grade level. Other manifestations of problems in school achievement for disadvantaged children include higher rates of special education placement, grade repetition, and dropping out of school. Ultimately, limited skills and low educational attainment increase the likelihood of undesirable outcomes in adulthood. Low educational attainment is associated with reduced rates of employment and with lower earnings for those who are employed. Use of social welfare programs is also higher among those with low educational attainment, as are crime and incarceration rates.

In introducing the 17-state report, Rouse, Brooks-Gunn, and McLanahan summarize the factors that the report identifies as crucial to child readiness for school as follows (p. 11)

In essence, the message of this issue is similar: taken together, family socioeconomic status, parenting, child health, maternal health and behaviors, and preschool attendance likely account for most of the racial and ethnic gaps in school readiness.<sup>10</sup>

The Head Start Child Development and Early Learning Framework<sup>11</sup> includes the following major categories of readiness of school: Cognition and General Knowledge; Language and Literacy; Approaches to Learning; Social and Emotional Development; and Physical Development and Health.

The model I present in this paper includes these categories (although not always using exactly the same terminology) in addition to the effects of minority and immigrant status on the factors that interact to influence the child’s readiness for school. It also includes the effects of single-parent or divorced and remarried parent status (vs. the effects of a stable marriage) and the effects of the parents’ level of educational attainment—which is known to have a strong influence on earnings and unemployment<sup>12</sup> and,

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<sup>10</sup> In a follow-up presentation to the *Future of Children* report, Brooks-Gunn, Rouse, and McLanahan provide a lot of detail about these variables in the context of racial and ethnic differences in school readiness.

<sup>11</sup> [https://eclkc.ohs.acf.hhs.gov/hslc/hs/sr/approach/pdf/ohsapproach-to-school-readiness\\_early-learning-framework.pdf](https://eclkc.ohs.acf.hhs.gov/hslc/hs/sr/approach/pdf/ohsapproach-to-school-readiness_early-learning-framework.pdf)

<sup>12</sup> U.S. Bureau of Labor Statistics, March 24, 2014, [www.bis.gov?emp/ep\\_chart\\_001.htm](http://www.bis.gov?emp/ep_chart_001.htm)

therefore, on such additional factors as neighborhood, family stress, nutrition, and health, etc.

The variables included in the model mirror many of those identified in the literature, for example, in a research brief (2005) made available by the RAND Corporation:<sup>13</sup>

Although most children experience a supportive home and neighborhood environment with access to sufficient financial and nonfinancial resources to support healthy development, many other children do not. A few indicators illustrate some of the resource disparities in early childhood:

- Poverty has been shown to be particularly detrimental in early childhood in terms of children's subsequent educational and other life course outcomes. In 2003, 4.7 million children under age 6 lived in families with income below the poverty line (defined as \$18,660 for a family of four or \$14,824 for a family of three, each with two children). While the poverty rate is 20 percent overall for children under 6, the rate is 53 percent among children that age living in a female-headed household, 39 percent for African-American children, and 32 percent for Latino children.
- Research has demonstrated that neighborhoods of concentrated poverty (typically defined as those with a poverty rate exceeding 20 percent) provide more limited opportunities for young children in terms of social interaction, positive role models, and other resources, such as quality child care, health facilities, parks, and playgrounds, that are important for healthy child development. Data from the 2000 Census reveal that 22 percent of children under 5 live in neighborhoods of concentrated poverty.
- Healthy child development is supported by regular access to health care, such as well-child visits. These visits can provide opportunities for health care providers to conduct developmental screenings and to encourage parental behaviors that promote strong social, emotional, cognitive, and physical child development. Nevertheless, among children less than 2 years old in 2002, 12 percent had not had a well-child checkup in the last year. That fraction rises to 16 percent among children ages 2 to 3 and 18 percent among those ages 4 to 5.

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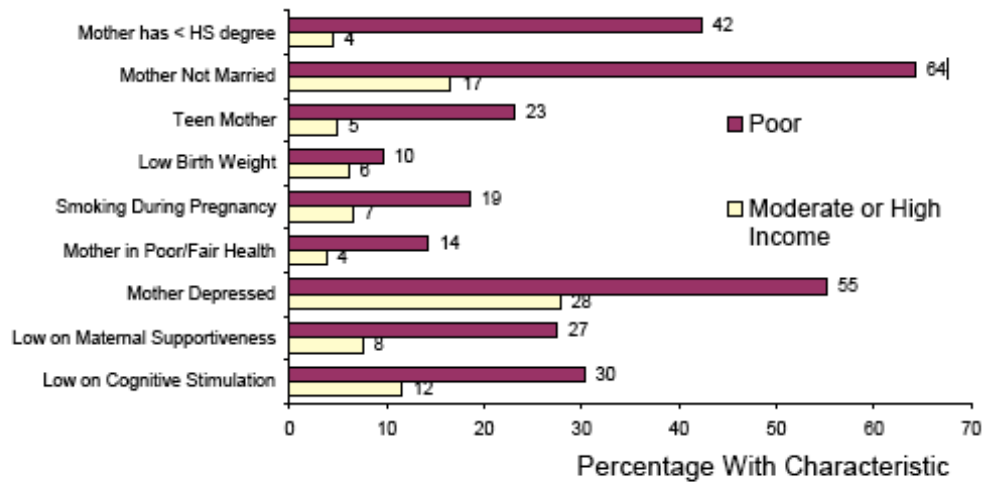
<sup>13</sup> RAND Corporation (2005). Children at Risk: Consequences for School Readiness and Beyond, 2-3.



- Early home literacy-building activities that are associated with better school performance in kindergarten and beyond include reading to a child regularly (3 or more times a week); teaching children letters, words, and numbers; and telling stories or teaching songs and music. Among children ages 3 to 5 in 2001, 16 percent are not read to regularly at home. Among children whose mothers have less than a high school education, that fraction rises to 31 percent, compared with just 7 percent for children whose mothers have a college degree.

Many of the model variables can also be found in the following graph from the Brookings Institution (2011):<sup>14</sup>

**Figure 3: Poor Families Differ from Moderate/High Income Families on Many Characteristics that May Affect School Readiness**



Source and Notes: Brookings tabulations of data from the Early Childhood Longitudinal Study-Birth Cohort (ECLS-B). Poor at birth is defined as household income less than 100 percent of poverty and moderate or high income is defined as household income at or above 185 percent of poverty. Prevalence of characteristics among near-poor children (incomes 100-185 percent) is not shown but always lies between the two other groups for all characteristics shown in the figure.

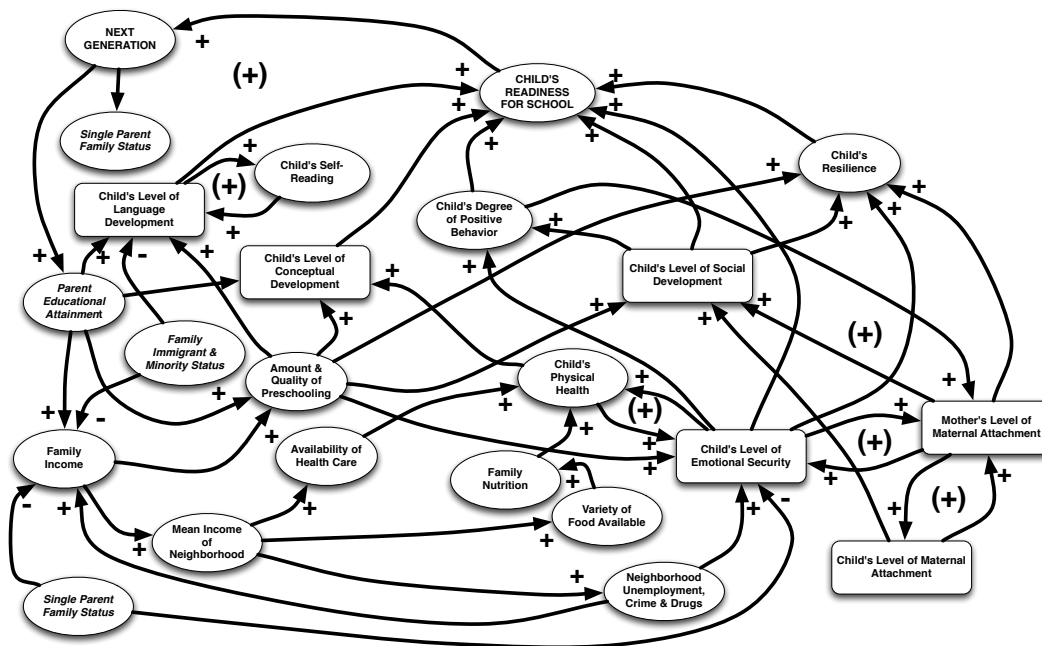
### Analysis

The purpose of this analysis is to depict the causal dynamics that, I hypothesize, explain the differences in readiness for school that, as described in the preceding introduction, are problematic—for academic achievement, peer relationships, psychological well being, teenage pregnancy, employment and earnings, and criminal activity (Finnegan, n.d., *op. cit.*).

<sup>14</sup> Isaacs, Julia B. (2012). Brookings Institution, Starting School at a Disadvantage: The School Readiness of Poor Children, 6.

The first step was to visualize the network of interacting variables in what is called a “causal-loop” or a “causal-influence” diagram (see Figure 4, below).

**Figure 4. Early Childhood Development Causal-Loop Diagram**



The central thesis of this perspective on the dynamics of early childhood development is that—unless there are effective interventions—these dynamics are driven in each generation by three “exogenous” variables. These three variables are (1) parental education, (2) immigrant/minority status (White/Asian vs. Black/Hispanic/Other, and (3) single-parent (vs. stable-marriage) family status, all of which are supported in the literature.<sup>15</sup>

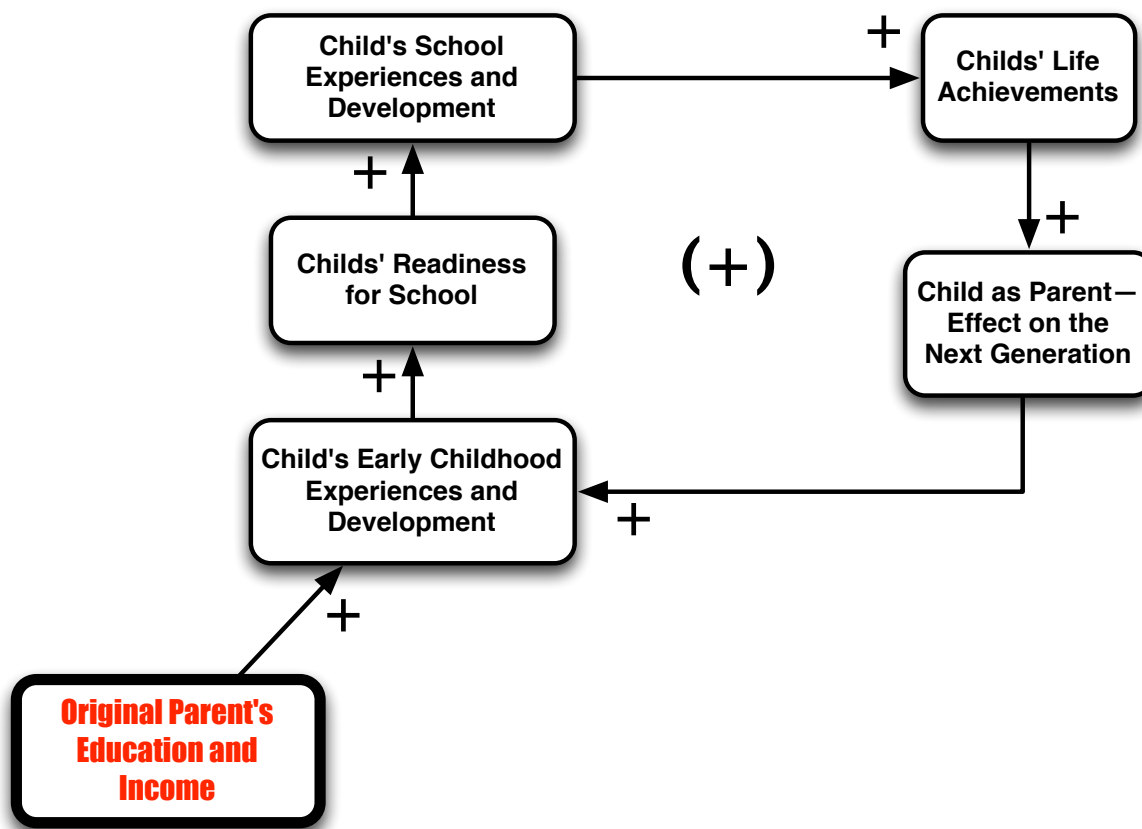
<sup>15</sup> “Children with college-educated mothers provide an exception to the general pattern: poor children whose mothers have a college degree or higher are as well-prepared for school as other children of college-educated mothers (but this small group represents only 2 percent of all poor children).” (Isaacs, Julia B. (2012). Brookings Institution, Starting School at a Disadvantage: The School Readiness of Poor Children, 4.

It is encouraging that the Social Genome Project, Center on Children and Families, Brookings Institution, identified a list of factors very similar to those that comprise my model as influencing school readiness:

“The demographic controls in this analysis include the parents’ level of education, marital status, and mother’s age at birth, as well race/ethnicity, immigrant status, gender, and age in months. Parents’ education is a large factor explaining why children from moderate and high income families enter school with higher reading and math skills—their parents are better educated. Children’s early academic skills are higher, on average, when parents have more years of schooling, and this association persists even after

It is further proposed, although not pursued in this analysis, that the effects are intergenerational (see Figure 5, below).

**Figure 5. Intergenerational Feedback Loop**



The next step in the analysis is to transform the causal-loop diagram into a System Dynamics computer simulation model (a so-called “stock-and-flow” diagram)—in outline format (see Appendix A), in visual format (see Figure 6, below), and mathematicized (see Appendix B for a list of the equations that comprise the computer simulation model). The great analytic value of a computer simulation model is twofold.

First, one can analyze the model as a description of “the way things are” (keeping in mind that, while based generally on understandings from the literature, the model constitutes a “theory of the problem”) and one can

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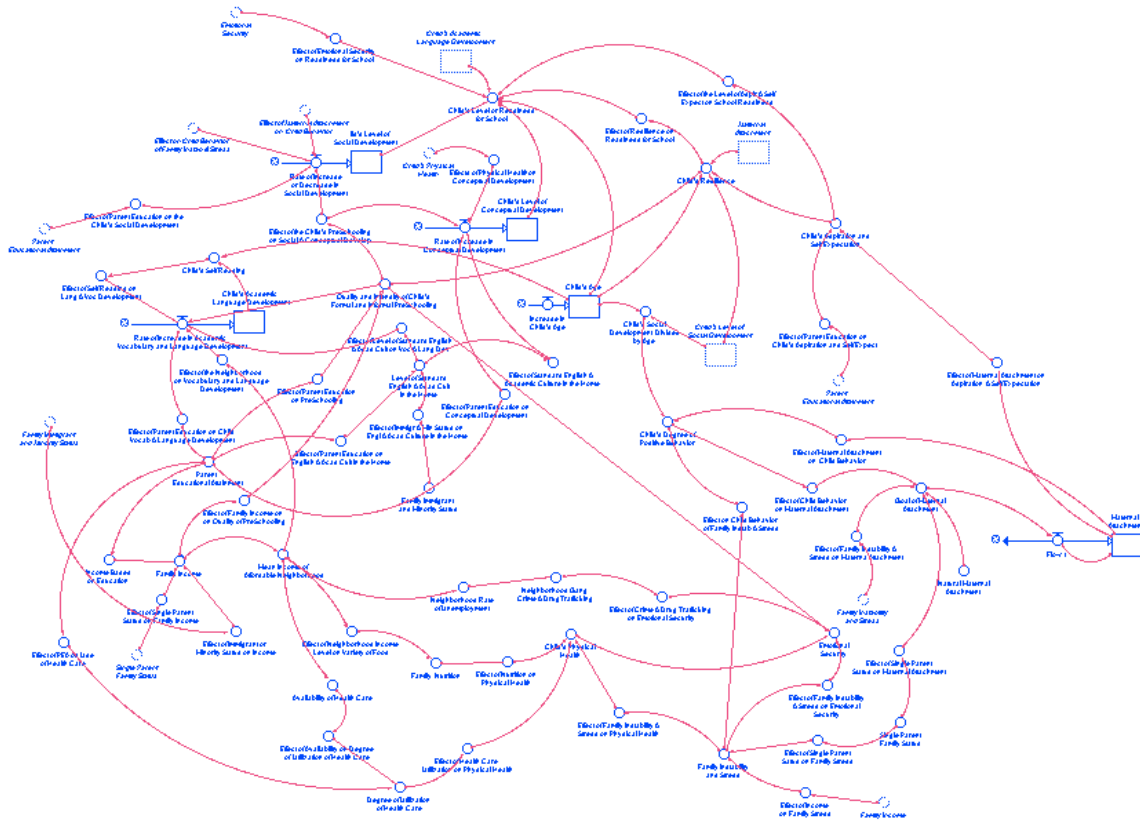
controlling for parents’ inherent abilities, according to evidence from welfare reform evaluations and sophisticated statistical analyses (Gennetian, Magnuson & Morris, 2008; Carneiro et al., 2007). In addition, the “education” effect also reflects underlying differences in parents’ skills and preferences, which are often passed on to their children, by both inherited traits and upbringing.” (*Ibid*, 6)

generate (that is, construct) interventions, some of which have been tried, and for which we have some effects data.

Secondly—and very importantly—one can alter the structure of the model “experimentally” and “run” the model as if one were trying out different interventions—without the risks and costs of empirical experimentation.

I did both of these things, and the remainder of this paper will be rooted in these two related, but different kinds, of analyses.

**Figure 6. The Computer Simulation Model**



*The Basic Model: Illustrative Simulation Results*

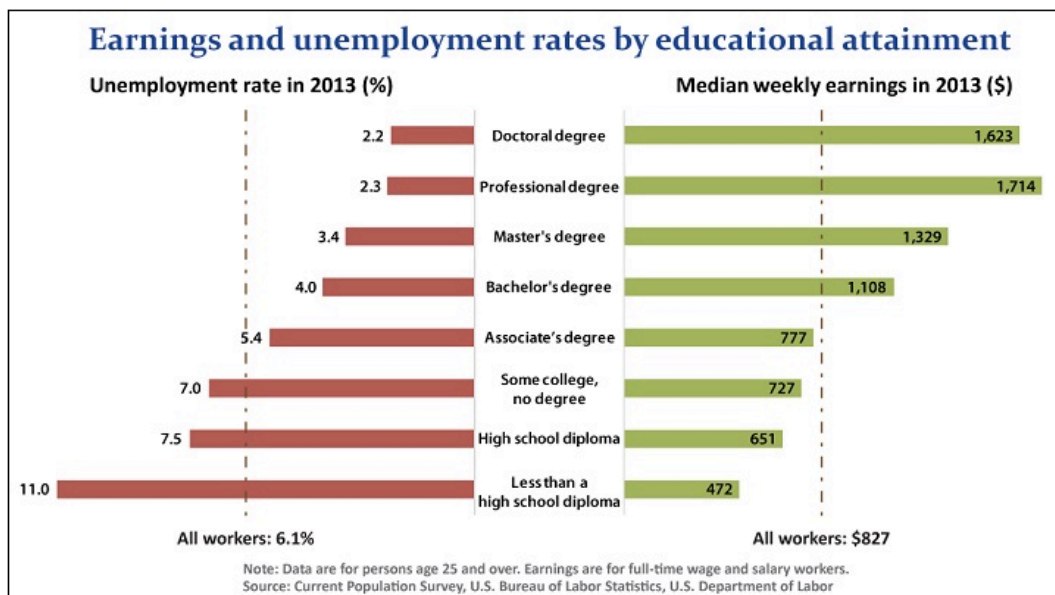
Having formulated a theoretical computer-simulation model of the current “system” of early childhood development—the “system” that produces a range of students’ readiness for school, it was then possible to run the model to see the extent to which it generated results consistent with what is known about the distribution of school readiness among students with different backgrounds. It is important to keep in mind, however, that the numbers from the computer simulation are illustrative only. That is, they show the effects—when run through the theoretical system of variables that comprise the model—that reflect the idea that different backgrounds tend, in general, to develop different levels of readiness for school among students. As noted

earlier, the numbers are only illustrative because the empirical research that has been done has not produced specific effect sizes among the variables that collectively, and interactively, generate different levels of school readiness.

### *A Theory of Early Childhood Development That Generates Significant Differences in School Readiness*

The report of the Center on Children and Families (Figure 1, *Supra*, p. 3) provides empirical data to indicate a 27% gap in school readiness between children of poor and moderate or high income families (48% vs. 75%). The theory presented in this analysis is that this discrepancy is the result of the playing out of interactions among a set of variables that are caused by the effects of exogenous differences in parental education,<sup>16 17</sup> low vs. high ethnic

<sup>16</sup> U.S. Bureau of Labor Statistics, U.S. Department of Labor (2013). Earnings and Unemployment Rates by Educational Attainment. (See table below)



[Data Table](#)

Note: Data are for persons age 25 and over. Earnings are for full-time wage and salary workers.

These education categories reflect only the highest level of education attained. They do not take into account completion of training programs in the form of apprenticeships and other on-the-job training, which may also influence earnings and unemployment rates. For more information on training, see: [http://www.bls.gov/emp/ep\\_table\\_education\\_summary.htm](http://www.bls.gov/emp/ep_table_education_summary.htm) and [http://www.bls.gov/emp/ep\\_table\\_education\\_by\\_train.htm](http://www.bls.gov/emp/ep_table_education_by_train.htm).

BLS has some data on the [employment status](#) of the civilian noninstitutional population 25 years and over by educational attainment, sex, race, and Hispanic origin online.

The Census Bureau also has some data on [educational attainment](#) online.

<sup>17</sup> Isaacs, Julia B. and Katherine Magnuson (2011). Income and Education as Predictors of Children’s School Readiness. Brookings Institution, Special Genome Project Research, Number 23.

and racial status,<sup>18</sup> and being a child of a stable marriage vs. being a child of single parent (unmarried or divorced mother) or of a second marriage.<sup>19</sup>

These interactions are shown in a causal-loop diagram (Figure 4, *Supra*, p. 9), a stock-and-flow diagram (Figure 6, *Supra*, p. 11), a word-based outline that describes how the variables interact (Appendix A, *Infra*, pp.19-31), and a set of equations (Appendix B, *Infra*, pp. 32-43) that facilitates the simulation of the basic theoretical model. An appropriate subset of these equations can later be modified to test structural changes in the model that represent various policy initiatives.

As the reader can see by examining these various model formats, the theory represented by the model projects the same variables (1) for children of well- and poorly-educated parents, (2) for Black, Hispanic, and non-Asian immigrant kids, on the one hand, and White and Asian kids, on the other, and (3) for children of single parents and of parents in stable marriages. However, it is the effects of the fundamental differences in the effects of these driver variables—working through the various interacting endogenous variables in the model—that, on average, produce the differences in school readiness among children at age five.

One can see that the theory posits a set of secondary variables that includes income and employment, neighborhood, family stress, maternal attachment, health, nutrition, aspiration and self-expectation, perseverance, language and vocabulary development, conceptual development, social development, aspiration and self-expectation, among others. It is the differences in the values of these secondary variables—in interaction with one another—that ultimately produce the differences among students in school readiness that is reported by the Center on Children and Families, differences shown in Figures 1, 2, and 3, above.

### *Running the Basic Model*

The model, which is displayed in the various formats noted, represents this “theory of the problem”—of the uneven distribution of readiness among five-year-olds entering school. It is important to observe that the causal effects in the model, with rare exception (e.g., the effect of education on income—which is projected in precise numbers from census data) are projected as general in nature [e.g., high (3), low (1), or medium (2), or as fractional values of “1”], that is, using general rather than exact effect sizes. This is

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<sup>18</sup> *The Future of Children* (2005). School Readiness: Closing Racial and Ethnic Gaps. Woodrow Wilson School of Public and International Affairs, Princeton University, and the Brookings Institution, 15(1), Spring.

<sup>19</sup> Amato, Paul R. (2005). The Impact of Family Formation Change on the Cognitive, Social, and Emotional Well-Being of the Next Generation, *Future of Children*, 15(2), Fall.

because my reading of the literature is that the research is essentially correlational, not experimental, in nature, and that exact effect sizes are generally unknown.<sup>20</sup>

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<sup>20</sup> There are several major problems with correlational research—in contrast to experimental research—when one is thinking systemically. One of these problems is that correlational findings—that is, the Beta weights—are dependent upon the inclusion or exclusion of variables in the regression analysis, and on the lack of covariability among these variables. The results can change along with the set of variables included. Another problem is implicit in this first problem: correlational findings are basically *systemic* in nature. That is, a regression analysis does not provide direct information about, let us say, the particular effect of Variable A on Variable B. Beta weights are not *effect sizes*; they do not show the causal effects of changes in one variable on changes in another.

I think that this essential point is consistent, for example, with a similar statement quoted from a *Harvard Business Review Press* article by Cass Sunstein and Reid Hastie in the *Wall Street Journal* (January 17, 2015):

“Unfortunately, it is always difficult to define the true causal factor in correlations of this type [high correlation between Factor C and performance on problem-solving tasks].”

Also, regression analysis tests for the *linear* relationships between the independent variables and the dependent variable:

Regression analysis also has an assumption of linearity. Linearity means that there is a straight line relationship between the IVs and the DV. This assumption is important because regression analysis only tests for a linear relationship between the IVs and the DV. Any nonlinear relationship between the IV and DV is ignored. You can test for linearity between an IV and the DV by looking at a bivariate scatterplot (i.e., a graph with the IV on one axis and the DV on the other). If the two variables are linearly related, the scatterplot will be oval. (Princeton University Library, Data and Statistical Services:

[http://dss.princeton.edu/online\\_help/analysis/regression\\_intro.htm](http://dss.princeton.edu/online_help/analysis/regression_intro.htm))

Thus, correlational analysis, on which most educational research related to the factors that influence school readiness are based, stands in contrast to the systemic analysis that is represented in this paper. The theory described in this paper is a theory of the interactions among a set of individual causal relationships that collectively account for the variability in school readiness among a representative sample of five-year-olds.

Unfortunately, as pointed out earlier in this paper, inter-variable causal effect sizes are generally unknown. Thus, in this theoretical paper, effect sizes are posited only in highly generalized forms—as high, medium, or low or as hypothesized fractional values between zero and one.

*Effects of Initial Conditions on Children’s Readiness for School*

The following table shows, in general, the ultimate effects in the model of parental education, minority and immigrant status, and stable or non-stable marriage on a child’s readiness for school:

**Figure 8: Effects of Minority and Immigrant Status on School Readiness**

<b>Parental Education</b>	<b>White or Asian &amp; Stable Marriage</b>	<b>White or Asian &amp; Single Parent or Re-Marriage</b>	<b>Other and Stable Marriage</b>	<b>Other and Single Parent or Re-Marriage</b>
10	2.88 (Standard)	2.84 (-1.4%)	2.85 (-1.04%)	2.84 (-1.4%)
12	4.28 (Standard)	3.34 (-22.0%)	3.42 (-20.1%)	3.23 (-24.5%)
14	4.62 (Standard)	3.93 (-14.9%)	4.53 (-1.9%)	3.68 (-20.3%)
16	5.56 (Standard)	4.59 (-17.4%)	5.13 (-7.7%)	4.47 (-19.6%)
18	6.04 (Standard)	5.86 (-3.0%)	5.91 (-2.2%)	5.16 (-15.0%)
20	6.48 (Standard)	6.29 (-2.9%)	6.22 (-4.0%)	6.02 (-7.1%)

As one can see, the effects of parental education are very strong in the model, regardless of other family conditions. Depending on parental education, the average child’s readiness for school at age five varies from a relative age of under three (10<sup>th</sup>-grade parental education) to over six (parent doctorate or equivalent).

Racial and ethnic effects, where parental education is constant, are not as strong in the model. If we treat a White or Asian stable marriage as the “standard,” then the loss in readiness (shown as the child’s relative “readiness age”) varies under different family conditions from -1.04% for children whose parents are non-Asian or non-White, with a minimal education, but with a stable marriage, to -24.5% for children whose parent(s) is(are) non-Asian or non-White, who is(are) high school graduates, but where there is either a single parent or there has been a re-marriage. In fact, it appears that given the relationships posited in this model that, other than parental education, the largest negative exogenous factor is single parenthood or divorce and re-marriage.

But it is important to keep in mind that educational attainment is already laden with the effects of race and ethnicity, so that effects that are attributed in the model—in which educational attainment is an independent exogenous variable—already incorporate some of the effects of race and ethnicity. So



that, for example, in a graph published by the National Center for Educational Statistics ([http://nces.ed.gov/programs/coe/indicator\\_caa.asp](http://nces.ed.gov/programs/coe/indicator_caa.asp), p. 3) the percentage of 25-29 year olds who completed a bachelor's degree or higher between 1990 and 2013 varied between 43 and 60 percent for Asian/Pacific Islanders, between 25 and 40 percent for Whites, between 13 and 22 percent for Blacks, and between 9 and 15 percent for Hispanics. Clearly, this makes the numbers in Figure 8 more consistent with what is empirically known.

In the same way, according to findings from the National Longitudinal Study of Youth 1979 (NLSY79 (Monthly Labor Review, Bureau of Labor Statistics, "Marriage and Divorce: Patterns by Gender, Race, and Educational Attainment," October 2013),<sup>21</sup> marriage and divorce patterns differ according to race and ethnicity. Keeping in mind that "Whites are about twice as likely as Blacks and Hispanics to have earned a bachelor's degree" (*Ibid*, p. 4), the difference in divorce rates between college graduates and those with less education translates into different divorce rates for Blacks and Hispanics compared to Whites.

(T)he divorce rate for first marriages is nearly 20 percentage points lower for those who have completed their bachelor's degree compared with those who have completed high school, regardless of whether they have some college or not. The gap is even greater, approaching 30 percentage points, when comparing those with a college degree to those with less than a high school diploma (*Ibid*, p. 6).

No wonder parental educational attainment has a strong effect on a child's readiness for school (as shown, above, in Figure 8). In addition to other characteristics that distinguish college graduates from those with less education, parental educational attainment carries the effects of race and ethnicity. Note that this is fully consistent with the theory of inter-generational effects illustrated in Figure 5 (*Supra*, p. 10). The point is that parental education in this generation is an outcome of the effects of early childhood development in the prior generation, which is precisely why reducing school readiness gaps—and subsequent academic achievement and educational attainment gaps—is so important.

### *Proposed Policy Goals*

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<sup>21</sup> The NLSY79 is a nationally representative sample of men and women who were ages 14 to 22 when they were first interviewed in 1979. Respondents were interviewed annually until 1994, and since then they have continued to be interviewed on a biennial basis. The NLSY79 collects detailed information on fertility, marital transitions, and employment in a format that allows one to determine the dating of the specific events. (Monthly Labor Review, Bureau of Labor Statistics, "Marriage and Divorce: Patterns by Gender, Race, and Educational Attainment," October 2013)

1. Decreasing the negative effects of low parental education on the quality of the child's early childhood education, vocabulary, and conceptual development.
2. Diminishing the effects of poverty and low parental education on child nutrition and health care
3. Diminishing the effects of parental education on low family income
4. Diminishing the effects of low income on family stress
5. Multiple interventions (1-4 Combined)

### *Experimental Results*

Structural changes were made in the model to mimic the effects of a set of experimental interventions, each of which is designed to accomplish one of the policy goals listed above. The effects of these simulated interventions are shown below in Figure 9 (below).

1. To simulate the first proposed intervention, changes were made to reduce the effect of low parental educational attainment on each of a set of cognitive effects, including the effect of low parental attainment on pre-schooling. This involved making the effects of parent education on each of these child development variables *the same* for parent educational attainment *up to grade 15*.
  - a. "Effect of Parent Education on Child Vocabulary and Language Development";
  - b. "Effect of Parent Education on English and Academic Culture in the Home";
  - c. "Effect of Parent Education on Conceptual Development"
  - d. "Effect of Parent Education on Pre-Schooling."
2. To simulate the second proposed intervention, changes were made to reduce the effect of low parental educational attainment on nutrition and health care. This involved making the effect on the availability of health care *the same up to a mean neighborhood income of \$48,000 a year* and making the effect on the variety of food *the same up to a mean neighborhood income of \$72,000 a year*.
3. To simulate the third proposed intervention, changes were made to reduce the effect of low parental educational attainment on income, raising minimum family income *from \$27,000 to \$50,000 a year regardless of parental educational attainment*.

4. To simulate the fourth proposed intervention, changes were made to make the effect of family income on family stress *the same up to \$90,000 a year*.
5. The fifth experiment looked at the effects on school readiness of combining all of the first four interventions.

### Effects of Other Test Interventions in the Model ¶

Parent Educational Attainment ¶ (Grade Level) ¶	Standard Asian-White Readiness ¶	Reduce Effect of Low Parent Education ¶ On Cognitive Development ¶	Reduce Effect of Low Parent Education on Health & Nutrition ¶	Reduce Effect of Low Parent Education on Income ¶	Reduce the Effect of Low Income on Family Stress ¶	Combination of All Four Interventions ¶
10 ¶	2.9 ¶	3.5 ¶ (21%) ¶	3.1 ¶ (07%) ¶	3.9 ¶ (34%) ¶	3.8 ¶ (31%) ¶	4.3 ¶ (48%) ¶
12 ¶	4.3 ¶	4.5 ¶ (5%) ¶	4.3 ¶ (0%) ¶	4.3 ¶ (0%) ¶	4.3 ¶ (0%) ¶	4.5 ¶ (5%) ¶
14 ¶	4.6 ¶	4.7 ¶ (2%) ¶	4.6 ¶ (0%) ¶	4.6 ¶ (0%) ¶	4.6 ¶ (0%) ¶	4.7 ¶ (2%) ¶
16 ¶	5.6 ¶	5.6 ¶ (0%) ¶	5.6 ¶ (0%) ¶	5.6 ¶ (0%) ¶	5.6 ¶ (0%) ¶	5.6 ¶ (0%) ¶
18 ¶	6.0 ¶	6.0 ¶ (0%) ¶	6.0 ¶ (0%) ¶	6.0 ¶ (0%) ¶	6.0 ¶ (0%) ¶	6.0 ¶ (0%) ¶
20 ¶	6.5 ¶	6.5 ¶ (0%) ¶	6.5 ¶ (0%) ¶	6.5 ¶ (0%) ¶	6.5 ¶ (0%) ¶	6.5 ¶ (0%) ¶

As expected, combining cognitive and academic interventions, health and nutrition interventions, and family stress interventions with straightforward increases in low family income had a very significant effect on the relative age of school readiness of children of parents with very low educational attainment (from a relative age of 2.9 years to a relative age of 4.3 years)—with very modest improvements in school readiness for children with parents who did not graduate from college. Of course, such a set of comprehensive interventions would require substantial time, effort, and money and, therefore, they probably have limited political feasibility.

At least theoretically in the model, the more limited, and less costly, interventions vary in their likely effectiveness. Those dealing with income and family stress seem theoretically to be potentially the most effective, with cognitive and academic interventions following. The least effective interventions, at least according to the model, are those that are directed solely at health and nutrition.

Let me say, once again, that the interventions tested have focused on the lowest parental educational achievement and the lowest family income group—those with parent educational attainment of tenth grade and family income of \$27,000 a year.

## *Conclusions*

What has been reported in this paper has been an exercise in systems analysis. The problem addressed, which has an extensive literature, is the variability in the readiness of five-year-olds for school. While the analysis is theoretical in nature—a kind of thought experiment—it is generally consistent with the literature on school readiness and early childhood development and yet, at the same time emphasizes the weaknesses in the current knowledge base. Most of the research available on the development of readiness for school is correlational in nature. What is needed—although it is difficult to do—is bivariate experimental research that would provide the effect sizes that are needed for more precise systemic analysis.

My overarching conclusion from thinking deeply about the “achievement gap” over the past several years, and looking systematically at the dynamics of both schooling and early childhood development, is not optimistic. The policies that work in schools to improve the achievement of initially low-readiness children work also to improve the achievement of initially average- and high-readiness students. This is not to say that we should not invest in “good schools”—strong school leadership, high quality teachers, rigorous curricula, and all the other factors that characterize “good schools.” Bringing initially low-readiness students closer to national academic achievement norms, even if other students do even better, is a virtuous effort.

At the level of early childhood development, as the analytic work reported in this paper suggest, implementing policies to close the “readiness gap” is costly, imperfect, and probably politically difficult. As was said by James Boutin, and reported in a blog by Valerie Strauss (*Washington Post*, December 24, 2014, <http://www.washingtonpost.com/blogs/answer-sheet/wp/2014/12/24/we-are-trying-to-close-the-achievement-gap-all-wrong-teacher/>) about a typical disadvantaged student used as an example:

Getting to and from school was not the only challenge Guillermo faced, though. His father abandoned his mother and siblings when he was 4 years old after some years of verbal and physical abuse, and his mom could not get a regular housing situation on her own. Although I didn't learn about these facts until after he'd left my classroom, it made a lot of sense. Guillermo was a student who had suffered the loss and abuse of his father, and the financial instability of his mother. On top of that, he struggled with the same challenges that teenagers who don't face such tremendous trauma deal with on a daily basis: hormonal changes, fitting in at school, and finding an identity.

As Michael Rebell, Campaign for Educational Equity, Teachers College, Columbia University, argued, as quoted in Layton's *Washington Post* article (*op. cit.*):

“We have to think about how to give these kids a meaningful education,” he said. “We have to give them quality teachers, small class sizes, up-to-date equipment. But in addition, if we're serious,

we have to do things that overcome the damages- of poverty. We have to meet their health needs, their mental health needs, after-school programs, summer programs, parent engagement, early-childhood services. These are the so-called wraparound services. Some people think of them as add-ons. They're not. They're imperative."

No, it's not easy and there's more to the problem than closing the school-readiness gap and the academic achievement gap, *per se*. There's also the larger task of closing the "life gap," the dramatic difference in standards of living that characterize families with different educational backgrounds and incomes—which goes well beyond scores on a limited range of high-stakes tests.

## Appendix A—CHILD DEVELOPMENT MODEL

### Outline

#### OUTPUT VARIABLE: Child's Level of Readiness for School

##### (1) Child's Level of Social Development

- a. Effect of Parent Education on the Child's Social Development
  - i. PARENT EDUCATIONAL ATTAINMENT [*Parent Educational Attainment, Single-Parent Status, and Immigrant or Minority Status (shown in ALL CAPS in the outline) are exogenous "driver" variables.*]
- b. Effect of the Child's Pre-schooling on Social and Conceptual Development
  - i. Quality and Intensity of the Child's Formal and Informal Pre-schooling
    - 1. Effect of Parent Education on Pre-schooling
      - a. PARENT EDUCATIONAL ATTAINMENT
    - 2. Effect of Family Income on the Quality of Pre-schooling
      - a. Family Income
        - i. Income Based on Education
          - 1. PARENT EDUCATIONAL ATTAINMENT
        - ii. Effect of Single-parent Status on Family Income
          - 1. SINGLE-PARENT STATUS
        - iii. Effect of Immigrant or Minority Status on Income
          - 1. IMMIGRANT OR MINORITY STATUS

- c. Effect on the Child's Behavior of Family Instability and Stress
    - i. Family Instability and Stress
      - 1. Effect of Income on Family Stress
        - a. Family Income
          - i. Income Based on Education
            - 1. PARENT EDUCATIONAL ATTAINMENT
          - ii. Effect of Single-parent Status on Family Income
            - 1. SINGLE-PARENT STATUS
          - iii. Effect of Immigrant or Minority Status on Income
            - 1. IMMIGRANT OR MINORITY STATUS
        - 2. Effect of Single Parent Status on Family Stress
          - i. SINGLE PARENT FAMILY STATUS
- d. Effect of Maternal Attachment on the Child's Behavior
  - i. Maternal Attachment
    - 1. Goal of Maternal Attachment
      - a. Goal of Maternal Attachment from Family Instability and Stress
        - i. Family Instability and Stress
          - 1. Effect of Income on Family Stress
            - a. Family Income
              - i. Income Based on Education
                - (a) PARENT EDUCATIONAL ATTAINMENT
              - ii. Effect of Single-parent Status on Family Income

## **Appendix A—CHILD DEVELOPMENT MODEL**

### **Outline**

#### **OUTPUT VARIABLE: Child's Level of Readiness for School**

##### **(2) Child's Level of Social Development**

- a. Effect of Parent Education on the Child's Social Development
  - i. PARENT EDUCATIONAL ATTAINMENT (variables shown in all caps are exogenous variables)
- b. Effect of the Child's Pre-schooling on Social and Conceptual Development
  - i. Quality and Intensity of the Child's Formal and Informal Pre-schooling
    - 1. Effect of Parent Education on Pre-schooling
      - a. PARENT EDUCATIONAL ATTAINMENT
    - 2. Effect of Family Income on the Quality of Pre-schooling
      - a. Family Income
        - i. Income Based on Education
          - 1. PARENT EDUCATIONAL ATTAINMENT
        - ii. Effect of Single-parent Status on Family Income
          - 1. SINGLE-PARENT STATUS
        - iii. Effect of Immigrant or Minority Status on Income
          - 1. IMMIGRANT OR MINORITY STATUS



- c. Effect on the Child's Behavior of Family Instability and Stress
  - i. Family Instability and Stress
    - 1. Effect of Income on Family Stress
      - a. Family Income
        - i. Income Based on Education
          - 1. PARENT EDUCATIONAL ATTAINMENT
        - ii. Effect of Single-parent Status on Family Income
          - 1. SINGLE-PARENT STATUS
        - iii. Effect of Immigrant or Minority Status on Income
          - 1. IMMIGRANT OR MINORITY STATUS
      - 2. Effect of Single Parent Status on Family Stress
        - i. SINGLE PARENT FAMILY STATUS
- d. Effect of Maternal Attachment on the Child's Behavior
  - i. Maternal Attachment
    - 1. Goal of Maternal Attachment
      - a. Goal of Maternal Attachment from Family Instability and Stress
        - i. Family Instability and Stress
          - 1. Effect of Income on Family Stress
            - a. Family Income
              - i. Income Based on Education
                - (b) PARENT EDUCATIONAL ATTAINMENT
              - ii. Effect of Single-parent Status on Family Income
                - (a) SINGLE-PARENT STATUS
              - iii. Effect of Immigrant or Minority Status on Income
                - (a) IMMIGRANT OR MINORITY STATUS

2. Effect of Single-parent Status on Family Stress
  - a. Effect of Single Parent Status on Family Stress
    - (i) SINGLE PARENT STATUS
- b. Goal of Maternal Attachment from Child Behavior
  - i. Child Degree of Positive Behavior
    1. Effect of Maternal Attachment on the Child's Behavior
    2. Effect on the Child's Behavior of Family Instability and Stress
      - a. Family Instability and Stress
        - i. Effect of Single-parent Status on Family Stress
          - (a) SINGLE-PARENT STATUS
        - ii. Effect of Income on Family Stress
          - (a) Family Income

**(3) Child's Level of Conceptual Development**

- a. Effect of Parent Education on Conceptual Development
  - i. PARENT EDUCATIONAL ATTAINMENT
- b. Effect of Standard English and Academic Culture in the Home
  - i. Level of Standard English and Academic Culture in the Home
    - 1. Effect of Immigrant and Minority Status on the English and Academic Culture in the Home
      - a. FAMILY IMMIGRANT AND MINORITY STATUS
    - 2. Effect of Parent Education on the English and Academic Culture in the Home
      - a. PARENT EDUCATIONAL ATTAINMENT
- c. Effect of Physical Health on Conceptual Development
  - i. Child's Physical Health
    - 1. Effect of Nutrition on Physical Health
      - a. Family Nutrition
        - i. Effect of Neighborhood Income on the Level and Variety of Food
          - 1. Mean Income of Affordable Neighborhood
            - a. Family Income
              - i. Income Based on Education
                - (a) PARENT EDUCATIONAL ATTAINMENT
              - ii. Effect of Single-parent Status on Family Income
                - (a) SINGLE-PARENT STATUS
              - iii. Effect of Immigrant or Minority Status on Income
                - (a) IMMIGRANT OR MINORITY STATUS
    - 2. Effect of Health Care Utilization on Physical Health
      - a. Degree of Utilization of Health Care
        - i. Effect of Parent Educational Attainment on Use of Health Care

- 1. PARENT EDUCATIONAL  
ATTAINMENT
- ii. Effect of Availability on Degree of  
Utilization of Health Care
  - 1. Availability of Health Care
    - a. Mean Income of  
Affordable  
Neighborhood
      - i. Family Income
        - (a) Income  
Based on  
Education
          - (i)  
PARENT  
EDUCAT  
IONAL  
ATTAIN  
MENT
        - ii. Effect of Single-  
parent Status on  
Family Income
          - (i)  
SINGLE-  
PARENT  
STATUS
        - iii. Effect of  
Immigrant or  
Minority Status  
on Income
          - (i)  
IMMIGR  
ANT OR  
MINORI  
TY  
STATUS

3. Effect of Family Instability and Stress on Physical Health
  - a. Family Instability and Stress
    - i. Effect of Income on Family Stress
      1. Family Income
        - a. Income Based on Education
          - i. PARENT EDUCATIONAL ATTAINMENT
        - b. Effect of Single-parent Status on Family Income
          - i. SINGLE-PARENT STATUS
        - c. Effect of Immigrant or Minority Status on Income
          - i. IMMIGRANT OR MINORITY STATUS

- ii. Level of Standard English and Academic Culture in the Home
  - 1. Effect of Immigrant and Minority Status on English and Academic Culture in the Home
    - a. FAMILY IMMIGRANT AND MINORITY STATUS
- d. Effect of Self-reading on Language and Vocabulary Development
  - i. Child's Self-reading
    - 1. Child's Academic Language Development
      - a. Effect of Self-reading on Language and Vocabulary Development
      - b. Effect of Parent Education on Child's Vocabulary and Language Development
        - i. PARENT EDUCATIONAL ATTAINMENT
      - c. Effect of the Neighborhood on Vocabulary and Language Development
        - i. Mean Income of Affordable Neighborhood
          - a. Family Income
            - i. Income Based on Education
              - PARENT EDUCATIONAL ATTAINMENT
            - ii. Effect of Single-parent Status on Family Income
              - SINGLE-PARENT STATUS
            - iii. Effect of Immigrant or Minority Status on Income
              - IMMIGRANT OR MINORITY STATUS

**(4) Child's Academic Language Development**

- a. Effect of Parent Education on Academic Vocabulary and Language Development
  - i. PARENT EDUCATIONAL ATTAINMENT
- b. Effect of Self-reading on Academic Vocabulary and Language Development
  - i. Child Self-reading
    - 1. Child Academic Language Development
- c. Effect of the Level of Standard English and Academic Culture on Vocabulary and Language Development
  - i. Level of Standard English and Academic Culture in the Home
    - 1. Effect of Parent Education on Standard English and Academic Culture in the Home
      - a. PARENT EDUCATIONAL ATTAINMENT
    - 2. Effect of Immigrant or Minority Status on Standard English and Academic Culture in the Home
      - a. IMMIGRANT OR MINORITY STATUS
- d. Effect of the Neighborhood on Vocabulary and Language Development
  - i. Mean Income of Affordable Neighborhood
    - a. Family Income
      - i. Income Based on Education
        - (c) PARENT EDUCATIONAL ATTAINMENT
      - ii. Effect of Single-parent Status on Family Income
        - (b) SINGLE-PARENT STATUS
      - iii. Effect of Immigrant or Minority Status on Income
        - (a) IMMIGRANT OR MINORITY STATUS

**(5) Effect of Emotional Security on Readiness for School**

- a. Child's Emotional Security
  - i. Effect of Family Instability and Stress on Emotional Security
  - ii. Child's Physical Health
  - iii. Effect of Crime and Drug Trafficking on Emotional Security
    - 1. Neighborhood Gang Crime and Drug Trafficking
      - a. Neighborhood Rate of Unemployment
        - i. Mean Income of Affordable Neighborhood
          - a. Family Income
            - i. Income Based on Education
              - (d) PARENT EDUCATIONAL ATTAINMENT
            - ii. Effect of Single-parent Status on Family Income
              - (c) SINGLE-PARENT STATUS
            - iii. Effect of Immigrant or Minority Status on Income
              - (a) IMMIGRANT OR MINORITY STATUS



**(6) Child: Effect of Resilience on Readiness for School**

a. Child's Resilience

i. Maternal Attachment

1. Goal of Maternal Attachment

a. Goal of Maternal Attachment from Family Instability and Stress

i. Family Instability and Stress

1. Effect of Income on Family Stress

a. Family Income

i. Income Based on Education

(e) PARENT EDUCATIONAL ATTAINMENT

ii. Effect of Single-parent Status on Family Income

(d) SINGLE-PARENT STATUS

iii. Effect of Immigrant or Minority Status on Income

(a) IMMIGRANT OR MINORITY STATUS

b. Goal of Maternal Attachment from Child Behavior

i. Child Degree of Positive Behavior

1. Effect of Maternal Attachment on the Child's Behavior

a. Maternal Attachment

2. Effect on the Child's Behavior of Family Instability and Stress

a. Family Instability and Stress

i. Effect of Single-parent Status on Family Stress

(a) SINGLE-PARENT STATUS

ii. Effect of Income on Family Stress

(a) Family Income

(1) Income Based on Education

(a) PARENT EDUCATIONAL ATTAINMENT

(2) Effect of Single Parent Status on Income

(a) SINGLE PARENT STATUS

(3) Effect of Immigrant or Minority Status on Income

(a) IMMIGRANT OR MINORITY STATUS

**(7) Effect of the Level of Aspiration and Self-Expectations on School Readiness**

a. Child's Aspiration and Self-expectation

i. Effect of Parent Education on the Child's Aspiration and Self-expectations

1. PARENT EDUCATIONAL ATTAINMENT

b. Effect of Maternal Attachment on Aspiration and Self-expectation

i. Maternal Attachment

1. Goal of Maternal Attachment

a. Goal of Maternal Attachment from Family Instability and Stress

i. Family Instability and Stress

1. Effect of Income on Family Stress

a. Family Income

i. Income Based on Education

(a) PARENT EDUCATIONAL ATTAINMENT

ii. Effect of Single-parent Status on Family Income

(a) SINGLE-PARENT STATUS

iii. Effect of Immigrant or Minority Status on Income

(a) IMMIGRANT OR MINORITY STATUS

b. Goal of Maternal Attachment from Child Behavior

i. Child Degree of Positive Behavior

1. Effect of Maternal Attachment on the Child's Behavior

a. Maternal Attachment

2. Effect on the Child's Behavior of Family Instability and Stress

a. Family Instability and Stress

i. Effect of Single-parent Status on Family Stress

(a) SINGLE-PARENT STATUS

ii. Effect of Income on Family Stress

(b) Family Income

(1) Income Based on Education

(a) PARENT EDUCATIONAL ATTAINMENT

(2) Effect of Single Parent Status on Income

(b) SINGLE PARENT STATUS

(3) Effect of Immigrant or Minority Status on Income

(a) IMMIGRANT OR MINORITY STATUS

## Appendix B—MODEL EQUATIONS

Child's\_Academic\_Language\_Development(t) =  
Child's\_Academic\_Language\_Development(t - dt) +  
(Rate\_of\_Increase\_in\_Academic\_Vocabulary\_and\_Language\_Development) \*  
dt

INIT Child's\_Academic\_Language\_Development = 0

### INFLOWS:

Rate\_of\_Increase\_in\_Academic\_Vocabulary\_and\_Language\_Development =  
1\*((Quality\_and\_Intensity\_of\_Child's\_Formal\_and\_Informal\_PreSchooling+Eff  
ect\_of\_the\_Neighborhood\_on\_Vocabulary\_and\_Language\_Development+2\*Eff  
ect\_of\_Parent\_Education\_on\_Child\_Vocab\_&\_Language\_Development+2\*Effect  
\_of\_Level\_of\_Standard\_English\_&\_Acad\_Cult\_on\_Voc\_&\_Lang\_Dev+Effect\_of\_Se  
lf\_Reading\_on\_Lang\_&\_Voc\_Development)/7)

Child's\_Age(t) = Child's\_Age(t - dt) + (Increase\_in\_Child's\_Age) \* dt

INIT Child's\_Age = 0.01

### INFLOWS:

Increase\_in\_Child's\_Age = 1

Child's\_Level\_of\_Conceptual\_Development(t) =  
Child's\_Level\_of\_Conceptual\_Development(t - dt) +  
(Rate\_of\_Increase\_in\_Conceptual\_Development) \* dt

INIT Child's\_Level\_of\_Conceptual\_Development = 0

**INFLOWS:**

Rate\_of\_Increase\_in\_Conceptual\_Development =

$(1 * ((3 * \text{Effect\_of\_Parent\_Education\_on\_Conceptual\_Development} + 2 * \text{Effect\_of\_the\_Child's\_PreSchooling\_on\_Social\ \&\_Conceptual\_Develop} + 2 * \text{Effect\_of\_Stand} \\ \text{ard\_English\ \&\_Academic\_Culture\_in\_the\_Home} + \text{Effects\_of\_Physical\_Healthon} \\ \text{\_Conceptual\_Development}) / 8))$

Child's\_Level\_of\_Social\_Development(t) =

Child's\_Level\_of\_Social\_Development(t - dt) +

(Rate\_of\_Increase\_or\_Decrease\_in\_Social\_Development) \* dt

INIT Child's\_Level\_of\_Social\_Development = 0

**INFLOWS:**

Rate\_of\_Increase\_or\_Decrease\_in\_Social\_Development =

$((\text{Effect\_of\_Maternal\_Attachment\_on\_Child\_Behavior} + \text{Effect\_on\_Child\_Behavi} \\ \text{or\_of\_Family\_Instab\ \&\_Stress} + \text{Effect\_of\_the\_Child's\_PreSchooling\_on\_Social} \\ \text{\ \&\_Conceptual\_Develop} + \text{Effect\_of\_Parent\_Education\_on\_the\_Child's\_Social\_De} \\ \text{velopment}) / 4)$

Maternal\_Attachment(t) = Maternal\_Attachment(t - dt) + (Flow\_1) \* dt

INIT Maternal\_Attachment = 2

**INFLOWS:**

Flow\_1 = Goal\_of\_Maternal\_Attachment - Maternal\_Attachment

Availability\_of\_Health\_Care =

GRAPH(Mean\_Income\_of\_Affordable\_Neighborhood)

(20000, 1.00), (27000, 1.00), (34000, 1.20), (41000, 1.75), (48000, 2.00),  
(55000, 2.20), (62000, 2.50), (69000, 2.50), (76000, 2.80), (83000, 3.00),  
(90000, 3.00)

Child's\_Aspiration\_and\_Self\_Expectation =

2\*((Effect\_of\_Parent\_Education\_on\_Child's\_Aspiration\_and\_Self\_Expect+Effect  
\_of\_Maternal\_Attachment\_on\_Aspiration\_&\_Self\_Expectation)/2)

Child's\_Degree\_of\_Positive\_Behavior = IF

(2\*(Child's\_Social\_Development\_Divided\_by\_Age\_Age\*((Effect\_of\_Maternal\_  
Attachment\_on\_Child\_Behavior+Effect\_on\_Child\_Behavior\_of\_Family\_Instab\_  
&\_Stress))))<3

THEN(((Child's\_Social\_Development\_Divided\_by\_Age\_Age\*((Effect\_of\_Matern  
al\_Attachment\_on\_Child\_Behavior+Effect\_on\_Child\_Behavior\_of\_Family\_Insta  
b\_&\_Stress)/2))) ELSE (3)

Child's\_Level\_or\_Readiness\_for\_School =

(Child's\_Age\*(Child's\_Level\_of\_Social\_Development/Child's\_Age+Child's\_Leve  
l\_of\_Conceptual\_Development/Child's\_Age+Child's\_Academic\_Language\_Dev  
elopment/Child's\_Age+Effect\_of\_the\_Level\_of\_Aspir\_&\_Self\_Expect\_on\_School  
\_Readiness+Effect\_of\_Resilience\_on\_Readiness\_for\_School+Effect\_of\_Emotion  
al\_Security\_on\_Readiness\_for\_School)/6)

Child's\_Physical\_Health = IF

((Effect\_of\_Health\_Care\_Utilization\_on\_Physical\_Health+Effect\_of\_Nutrition\_on\_Physical\_Health)/2)\*Effect\_of\_Family\_Instability\_&\_Stress\_on\_Physical\_Health)<3 THEN

(Effect\_of\_Health\_Care\_Utilization\_on\_Physical\_Health+Effect\_of\_Nutrition\_on\_Physical\_Health)/2\*Effect\_of\_Family\_Instability\_&\_Stress\_on\_Physical\_Health ELSE 3

Child's\_Resilience =

(Child's\_Level\_of\_Social\_Development/Child's\_Age+Child's\_Aspiration\_and\_Self\_Expectation+Quality\_and\_Intensity\_of\_Child's\_Formal\_and\_Informal\_PreSchooling+2\*Maternal\_Attachment)/5

Child's\_Self\_Reading =

Child's\_Academic\_Language\_Development/Child's\_Age

Child's\_Social\_Development\_Divided\_by\_Age\_Age =

Child's\_Level\_of\_Social\_Development/Child's\_Age

Degree\_of\_Utilization\_of\_Health\_Care = IF

(2\*((3\*Effect\_of\_Availability\_on\_Degree\_of\_Utilization\_of\_Health\_Care+2\*Effect\_of\_PEA\_on\_Use\_of\_Health\_Care)/5))<3 THEN

((3\*Effect\_of\_Availability\_on\_Degree\_of\_Utilization\_of\_Health\_Care+2\*Effect\_of\_PEA\_on\_Use\_of\_Health\_Care)/5) ELSE (3)



Effects\_of\_Physical\_Health\_on\_Conceptual\_Development =

GRAPH(Child's\_Physical\_Health)

(1.00, 0.7), (1.20, 0.75), (1.40, 0.8), (1.60, 0.85), (1.80, 0.9), (2.00, 1.00), (2.20, 1.20), (2.40, 1.30), (2.60, 1.35), (2.80, 1.40), (3.00, 1.50)

Effect\_of\_Availability\_on\_Degree\_of\_Utilization\_of\_Health\_Care =

GRAPH(Availability\_of\_Health\_Care)

(1.00, 0.5), (1.20, 0.5), (1.40, 0.5), (1.60, 0.6), (1.80, 0.7), (2.00, 0.8), (2.20, 0.85), (2.40, 0.9), (2.60, 1.00), (2.80, 1.00), (3.00, 1.00)

Effect\_of\_Child\_Behavior\_on\_Maternal\_Attachment =

GRAPH(Child's\_Degree\_of\_Positive\_Behavior)

(1.00, 0.67), (1.20, 0.7), (1.40, 0.7), (1.60, 0.75), (1.80, 0.8), (2.00, 0.9), (2.20, 0.95), (2.40, 1.00), (2.60, 1.00), (2.80, 1.10), (3.00, 1.20)

Effect\_of\_Crime\_&\_Drug\_Trafficking\_on\_Emotional\_Security =

GRAPH(Neighborhood\_Gang\_Crime\_&\_DrugTrafficking)

(1.00, 1.00), (1.20, 1.00), (1.40, 0.95), (1.60, 0.9), (1.80, 0.85), (2.00, 0.8), (2.20, 0.75), (2.40, 0.7), (2.60, 0.65), (2.80, 0.6), (3.00, 0.5)

Effect\_of\_Emotional\_Security\_on\_Readiness\_for\_School =

GRAPH(Emotional\_Security)

(0.00, 0.7), (0.3, 0.00), (0.6, 0.7), (0.9, 0.75), (1.20, 0.75), (1.50, 0.75), (1.80, 0.85), (2.10, 1.00), (2.40, 1.00), (2.70, 1.10), (3.00, 1.20)

Effect\_of\_Family\_Income\_on\_on\_Quality\_of\_PreSchooling =

GRAPH(Family\_Income)

(20000, 0.7), (33000, 0.8), (46000, 0.9), (59000, 0.95), (72000, 1.00), (85000, 1.00), (98000, 1.20), (111000, 1.30), (124000, 1.35), (137000, 1.40), (150000, 1.50)

Effect\_of\_Family\_Instability\_&\_Stress\_on\_Emotional\_Security =

GRAPH(Family\_Instability\_and\_Stress)

(1.00, 1.20), (1.20, 1.10), (1.40, 1.00), (1.60, 0.9), (1.80, 0.85), (2.00, 0.8), (2.20, 0.75), (2.40, 0.7), (2.60, 0.65), (2.80, 0.6), (3.00, 0.5)

Effect\_of\_Family\_Instability\_&\_Stress\_on\_Materna\_Attachment =

GRAPH(Family\_Instability\_and\_Stress)

(1.00, 1.20), (1.20, 1.10), (1.40, 1.00), (1.60, 1.00), (1.80, 0.95), (2.00, 0.9), (2.20, 0.8), (2.40, 0.75), (2.60, 0.7), (2.80, 0.7), (3.00, 0.67)

Effect\_of\_Family\_Instability\_&\_Stress\_on\_Physical\_Health =

GRAPH(Family\_Instability\_and\_Stress)

(1.00, 1.20), (1.20, 1.10), (1.40, 1.00), (1.60, 0.9), (1.80, 0.85), (2.00, 0.8), (2.20, 0.75), (2.40, 0.7), (2.60, 0.65), (2.80, 0.6), (3.00, 0.5)

Effect\_of\_Health\_Care\_Utilization\_on\_Physical\_Health =

Degree\_of\_Utilization\_of\_Health\_Care

Effect\_of\_Immigrant\_or\_Minority\_Status\_on\_Income = IF  
(Family\_Immigrant\_and\_Minority\_Status = 1) THEN (.8) ELSE (1)

Effect\_of\_Immigr\_&Min\_Status\_on\_Engl\_&Acad\_Culture\_in\_the\_Home = IF  
(Family\_Immigrant\_and\_Minority\_Status=1) THEN (.8) ELSE (1)

Effect\_of\_Income\_on\_Family\_Stress = IF (Family\_Income<50000) THEN (3)  
ELSE IF (Family\_Income<90000) THEN (2) ELSE (1)

Effect\_of\_Level\_of\_Standard\_English\_&Acad\_Cult\_on\_Voc\_&Lang\_Dev =  
GRAPH(Level\_of\_Standard\_English\_&Acad\_Cult\_in\_the\_Home)  
(1.00, 0.5), (1.20, 0.6), (1.40, 0.7), (1.60, 0.8), (1.80, 0.9), (2.00, 1.00), (2.20,  
1.00), (2.40, 1.00), (2.60, 1.00), (2.80, 1.10), (3.00, 1.20)

Effect\_of\_Maternal\_Attachment\_on\_Aspiration\_&Self\_Expectation =

GRAPH(Maternal\_Attachment)  
(1.00, 0.5), (1.20, 0.5), (1.40, 0.5), (1.60, 0.6), (1.80, 0.7), (2.00, 0.8), (2.20,  
0.85), (2.40, 0.9), (2.60, 1.00), (2.80, 1.00), (3.00, 1.20)

Effect\_of\_Maternal\_Attachment\_on\_Child\_Behavior =  
GRAPH(Maternal\_Attachment)  
(1.00, 0.7), (1.20, 0.75), (1.40, 0.8), (1.60, 0.85), (1.80, 0.9), (2.00, 1.00), (2.20,  
1.10), (2.40, 1.20), (2.60, 1.25), (2.80, 1.30), (3.00, 1.35)

Effect\_of\_Neighborhood\_Income\_Level\_on\_Variety\_of\_Food =  
GRAPH(Mean\_Income\_of\_Affordable\_Neighborhood)

(20000, 1.00), (33000, 1.00), (46000, 1.20), (59000, 1.75), (72000, 2.00),  
(85000, 2.20), (98000, 2.50), (111000, 2.50), (124000, 2.80), (137000, 3.00),  
(150000, 3.00)

Effect\_of\_Nutrition\_on\_Physical\_Health = Family\_Nutrition

Effect\_of\_Parent\_Education\_on\_Child's\_Aspiration\_and\_Self\_Expect =

GRAPH(Parent\_\_Educational\_Attainment)

(10.0, 1.00), (11.0, 1.30), (12.0, 1.50), (13.0, 1.75), (14.0, 2.00), (15.0, 2.10),  
(16.0, 2.70), (17.0, 2.80), (18.0, 3.00), (19.0, 3.00), (20.0, 3.00)

Effect\_of\_Parent\_Education\_on\_Child\_Vocab\_&\_Language\_Development =

GRAPH(Parent\_\_Educational\_Attainment)

(10.0, 0.7), (11.0, 0.8), (12.0, 0.9), (13.0, 0.95), (14.0, 1.00), (15.0, 1.00), (16.0,  
1.20), (17.0, 1.30), (18.0, 1.35), (19.0, 1.40), (20.0, 1.50)

Effect\_of\_Parent\_Education\_on\_Conceptual\_Development =

GRAPH(Parent\_\_Educational\_Attainment)

(10.0, 0.7), (11.0, 0.75), (12.0, 0.8), (13.0, 0.85), (14.0, 0.9), (15.0, 1.00), (16.0,  
1.20), (17.0, 1.30), (18.0, 1.35), (19.0, 1.40), (20.0, 1.50)

Effect\_of\_Parent\_Education\_on\_English\_&\_Acad\_Cult\_in\_the\_Home =

GRAPH(Parent\_\_Educational\_Attainment)

(10.0, 0.5), (11.0, 0.55), (12.0, 0.6), (13.0, 0.7), (14.0, 0.9), (15.0, 1.00), (16.0,  
1.20), (17.0, 1.30), (18.0, 1.35), (19.0, 1.40), (20.0, 1.50)

Effect\_of\_Parent\_Education\_on\_PreSchooling =

GRAPH(Parent\_\_Educational\_Attainment)

(10.0, 0.7), (11.0, 0.8), (12.0, 0.9), (13.0, 0.95), (14.0, 1.00), (15.0, 1.00), (16.0, 1.20), (17.0, 1.30), (18.0, 1.35), (19.0, 1.40), (20.0, 1.50)

Effect\_of\_Parent\_Education\_on\_the\_Child's\_Social\_Development =

GRAPH(Parent\_\_Educational\_Attainment)

(10.0, 0.7), (11.0, 0.8), (12.0, 0.9), (13.0, 0.95), (14.0, 1.00), (15.0, 1.00), (16.0, 1.20), (17.0, 1.30), (18.0, 1.35), (19.0, 1.40), (20.0, 1.50)

Effect\_of\_PEA\_on\_Use\_of\_Health\_Care =

GRAPH(Parent\_\_Educational\_Attainment)

(10.0, 1.00), (11.0, 1.00), (12.0, 1.00), (13.0, 2.00), (14.0, 2.00), (15.0, 2.00), (16.0, 3.00), (17.0, 3.00), (18.0, 3.00), (19.0, 3.00), (20.0, 3.00)

Effect\_of\_Resilience\_on\_Readiness\_for\_School = GRAPH(Child's\_Resilience)

(1.00, 0.5), (1.20, 0.6), (1.40, 0.7), (1.60, 0.8), (1.80, 0.9), (2.00, 1.00), (2.20, 1.00), (2.40, 1.00), (2.60, 1.00), (2.80, 1.10), (3.00, 1.20)

Effect\_of\_Self\_Reading\_on\_Lang\_&\_Voc\_Development =

GRAPH(Child's\_Self\_Reading)

(1.00, 0.5), (1.20, 0.6), (1.40, 0.7), (1.60, 0.8), (1.80, 0.9), (2.00, 1.00), (2.20, 1.00), (2.40, 1.00), (2.60, 1.00), (2.80, 1.10), (3.00, 1.20)

Effect\_of\_Single\_Parent\_Status\_on\_Family\_Stress = IF

(Single\_Parent\_Family\_Status=1) THEN (1.2) ELSE (1)

Effect\_of\_Single\_Parent\_Status\_on\_Family\_Income = IF  
(Single\_Parent\_Family\_Status=1) THEN (.75) ELSE (1)

Effect\_of\_Single\_Parent\_Status\_on\_Maternal\_Attachment = IF  
(Single\_Parent\_Family\_Status=1) THEN (.9) ELSE (1)

Effect\_of\_Standard\_English\_&Academic\_Culture\_in\_the\_Home =  
GRAPH(Level\_of\_Standard\_English\_&Acad\_Cult\_in\_the\_Home)  
(1.00, 0.7), (1.20, 0.75), (1.40, 0.8), (1.60, 0.85), (1.80, 0.9), (2.00, 1.00), (2.20,  
1.20), (2.40, 1.30), (2.60, 1.35), (2.80, 1.40), (3.00, 1.50)

Effect\_of\_the\_Child's\_PreSchooling\_on\_Social\_&Conceptual\_Develop =  
GRAPH(Quality\_and\_Intensity\_of\_Child's\_Formal\_and\_Informal\_PreSchooling  
)  
(1.00, 0.7), (1.20, 0.7), (1.40, 0.7), (1.60, 0.8), (1.80, 0.85), (2.00, 0.9), (2.20,  
1.00), (2.40, 1.00), (2.60, 1.10), (2.80, 1.30), (3.00, 1.50)

Effect\_of\_the\_Level\_of\_Aspir\_&Self\_Expect\_on\_School\_Readiness =  
GRAPH(Child's\_Aspiration\_and\_Self\_Expectation)  
(1.00, 0.5), (1.20, 0.5), (1.40, 0.5), (1.60, 0.6), (1.80, 0.7), (2.00, 0.8), (2.20,  
0.85), (2.40, 0.9), (2.60, 1.00), (2.80, 1.00), (3.00, 1.20)

Effect\_of\_the\_Neighborhood\_on\_Vocabulary\_and\_Language\_Development =  
GRAPH(Mean\_Income\_of\_Affordable\_Neighborhood)

(20000, 0.5), (33000, 0.6), (46000, 0.7), (59000, 0.8), (72000, 0.9), (85000, 1.00), (98000, 1.00), (111000, 1.00), (124000, 1.00), (137000, 1.20), (150000, 1.50)

Effect\_on\_Child\_Behavior\_of\_Family\_Instab\_&\_Stress =

GRAPH(Family\_Instability\_and\_Stress)

(1.00, 1.00), (1.20, 1.00), (1.40, 1.00), (1.60, 1.00), (1.80, 1.00), (2.00, 1.00), (2.20, 0.9), (2.40, 0.7), (2.60, 0.6), (2.80, 0.55), (3.00, 0.5)

Emotional\_Security =

((Quality\_and\_Intensity\_of\_Child's\_Formal\_and\_Informal\_PreSchooling+Child's\_Physical\_Health)/2)\*(Effect\_of\_Crime\_&\_Drug\_Trafficking\_on\_Emotional\_Security+Effect\_of\_Family\_Instability\_&\_Stress\_on\_Emotional\_Security)/2)

Family\_Immigrant\_and\_Minority\_Status = 2

Family\_Income =

(Income\_Based\_on\_Education\*Effect\_of\_Immigrant\_or\_Minority\_Status\_on\_Income)\*Effect\_of\_Single\_Parent\_Status\_on\_Family\_Income

Family\_Instability\_and\_Stress = IF

(Effect\_of\_Income\_on\_Family\_Stress\*Effect\_of\_Single\_Parent\_Status\_on\_Family\_Stress)<3 THEN

(Effect\_of\_Income\_on\_Family\_Stress\*Effect\_of\_Single\_Parent\_Status\_on\_Family\_Stress) ELSE 3

Family\_Nutrition =

Effect\_of\_Neighborhood\_Income\_Level\_on\_Variety\_of\_Food

Goal\_of\_Maternal\_Attachment = IF

(Natural\_Maternal\_Attachment\*Effect\_of\_Child\_Behavior\_on\_Maternal\_Attachment\*Effect\_of\_Single\_Parent\_Status\_on\_Maternal\_Attachment\*Effect\_of\_Family\_Instability\_&\_Stress\_on\_Maternal\_Attachment)<3 THEN

(Natural\_Maternal\_Attachment\*Effect\_of\_Child\_Behavior\_on\_Maternal\_Attachment\*Effect\_of\_Single\_Parent\_Status\_on\_Maternal\_Attachment\*Effect\_of\_Family\_Instability\_&\_Stress\_on\_Maternal\_Attachment) ELSE 3

Income\_Based\_on\_Education = GRAPH(Parent\_\_Educational\_Attainment)

(10.0, 25000), (11.0, 35000), (12.0, 50000), (13.0, 55000), (14.0, 70000),  
(15.0, 75000), (16.0, 90000), (17.0, 100000), (18.0, 120000), (19.0, 130000),  
(20.0, 150000)

Level\_of\_Standard\_English\_&\_Acad\_Cult\_in\_the\_Home =

2\*Effect\_of\_Parent\_Education\_on\_English\_&\_Acad\_Cult\_in\_the\_Home\*Effect\_of\_Immigr\_&\_Min\_Status\_on\_Engl\_&\_Acad\_Culture\_in\_the\_Home

Mean\_Income\_of\_Affordable\_Neighborhood = Family\_Income

Natural\_Maternal\_Attachment = 3

Neighborhood\_Gang\_Crime\_&\_DrugTrafficking =

GRAPH(Neighborhood\_Rate\_of\_Unemployment)

(2.25, 1.00), (3.12, 1.00), (4.00, 1.00), (4.88, 1.50), (5.75, 1.80), (6.62, 2.00),  
(7.50, 2.50), (8.38, 2.75), (9.25, 3.00), (10.1, 3.00), (11.0, 3.00)



Neighborhood\_Rate\_of\_Unemployment =

GRAPH(Mean\_Income\_of\_Affordable\_Neighborhood)

(20000, 11.0), (33000, 10.0), (46000, 7.50), (59000, 7.00), (72000, 5.40),

(85000, 5.00), (98000, 4.00), (111000, 3.40), (124000, 3.20), (137000, 2.25),

(150000, 2.25)

Parent\_Educational\_Attainment = 16

Quality\_and\_Intensity\_of\_Child's\_Formal\_and\_Informal\_PreSchooling =

$2 * ((\text{Effect\_of\_Family\_Income\_on\_on\_Quality\_of\_PreSchooling} + \text{Effect\_of\_Parent\_Education\_on\_PreSchooling}) / 2)$

Single\_Parent\_Family\_Status = 2