Preliminary Analysis Report **

Statistical Causal Modeling and the Effect of School Librarians on Academic Achievement: Moving beyond Descriptive Statistics and Simple Correlations

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Background
Among the different school factors contributing to student achievement, researchers have frequently focused on the allocation of school resources as significant contributors to student learning. Educational resources such as class size, teacher educational levels and overall funding have been extensively researched for their effect. One school resource that has been advanced as having an effect on student learning is the school librarian. In an extensive literature review and meta-analysis of school librarians and student achievement (in press), we found that despite the hundreds of articles purporting to present "evidence" of the effect of school librarians on student achievement, the majority of these reported studies of a "school librarian effect" on achievement suffered from serious design and methodological weaknesses. The evidence provided in most cases was weak or non-existent. Historically school library studies have reflected at best a very limited empirical approach, with very small or non-representative samples; weak, descriptive research designs that offer no controls for prior achievement, student demographics or school characteristics; the use of outcome measures that are often perceptual, rather than substantive; and analytic techniques typically using descriptive or simple correlational statistical techniques. No large-scale, randomized control trials are reflected in the many school library studies and reports, and in fact, there are only a few larger-scale, quasi-experimental designs that even show up in any formal, peer-reviewed publications or reports over the past few decades. Despite the lack of significant peer-reviewed empirical research supporting their efforts, school librarians and their supporters, have been forced to rely on the volume of weak studies in their field, arguing for their effectiveness based on the preponderance of studies available, without much real empirical basis for their claims.

In our research we set an initial goal of answering a few basic empirical questions about the impact of a school librarian on student achievement, while at the same time, addressing as many of these weaknesses of prior studies as possible. While no research is without significant, challenges, we believe that we are addressing the majority of the limitations of prior studies. Our very first research question was: Does having at least one full-time, certified librarian in a school building positively impact student achievement? Our expectation was also that if school librarians did have a greater impact on student achievement, the area it would be easiest to see this impact would be in English language arts achievement. However, we wanted to look at another discipline as well so we focused on mathematics achievement as well.

Based on a prior year's data modeling success (Radlick & Stefl-Mabry, 2015), we submitted and received an IMLS Research Grant (RE-04-15-0081-15) to continue researching the effect of school librarians on student achievement. The preliminary report that follows summarizes the results from our first full series of statistical causal modeling subsequent to the IMLS grant. These results will be presented in much greater detail and more formally through a number of published research articles, a few of which are in progress now. However, because of strong

interest from researchers and practitioners throughout the library community, we are summarizing our first results in this preliminary report. This report will not provide an extensive detail on the results or the underlying methodologies because those details will be reflected in the upcoming publications that we are in process of submitting. However, readers should note that our subsequent follow-on research under this three-year IMLS grant (RE-04-15-0081-15) will examine in greater detail the relationships between student achievement and both school library characteristics and library services within the context of these causal models. We will focus on expanding the models in a number of ways, analyzing the widest range of school library variables within the context of all the other school and student related variables we have used throughout the study.

Design/Methodology

The statistical modeling uses observational data summarized from individual data to the school building and district levels. The data were provided through the New York State Education Department (NYSED) or was available from the NYSED website. Information about school librarians and their programs came from the New York State Education Department's Basic Educational Data Systems (BEDS) survey collected each year from school buildings across New York State. The BEDS survey data reflects the understandings and perspectives of the person responding from districts. To address the issue of scope and representativeness, models include data for all public schools in New York State, separated into two separate analysis sets-- New York City Public Schools and all other public schools in New York (Rest of State-ROS).[1] Note that there were 1,072 public school buildings in New York City with Grade 3 to Grade 8 ELA/Math assessment data, and 418 public school buildings in New York City (NYC) with Regents English or Integrated Algebra scores. In terms of the rest of the state outside NYC, there were 2,205 public school buildings with Grade 3 to Grade 8 ELA/Math assessment data, and 718 public school buildings with Regents English or Integrated Algebra scores.[2]

The target year being examined for the outcomes was school year 2012-13, which is the first year that New York State used Common Core Standards-based assessments for students in grades 3 to 8. Since the school librarian (or librarians) in a building can be considered a school-level resource, potentially effecting students across all grades in that school, the school building was the unit of analysis and the academic outcome measures were calculated for each building.[3]

The 16 different outcome (dependent) variables that were used in the modeling for the analysis sets are shown in Table 1.

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[1] Although charter schools are considered public schools, school library related data are not collected from any charter schools by the New York State Education Department). Therefore, charter schools are excluded from all analyses.

2 Note that the actual type of school (e.g. K-8, K-12, 7-8, 9-12) in any model could vary substantially. The groupings were based on whether there was assessment data from students taking that assessment at whichever grade level they were at.

Table 1: Student Achievement Outcome Measures for Each School Building

New York City Public Schools
- NYS ELA Performance Index for ELA (2012-13) Grades 3 to 8
- NYS Math Performance Index for Math (2012-13) Grades 3 to 8
- Change in ELA Performance Index from 2011-12 to 2012-13
- Change in Math Performance Index from 2011-12 to 2012-13
- NYS English Regents Performance Index (2012-13)
- NYS Integrated Algebra Performance Index (2012-13)
- Change in English Regents English Performance Index 2011-12 to 2012-13
- Change in Integrated Algebra Regents Performance Index 2011-12 to 2012-13

All Public Schools Outside of New York City
- NYS ELA Performance Index for ELA (2012-13) Grades 3 to 8
- NYS Math Performance Index for Math (2012-13) Grades 3 to 8
- Change in ELA Performance Index from 2011-12 to 2012-13
- Change in Math Performance Index from 2011-12 to 2012-13
- NYS English Regents Performance Index (2012-13)
- NYS Integrated Algebra Performance Index (2012-13)
- Change in English Regents English Performance Index 2011-12 to 2012-13
- Change in Integrated Algebra Regents Performance Index 2011-12 to 2012-13

The Performance Index outcome measures are calculated for each building in the same way for both NYC and the rest of the state, however the study analyzed each of these outcome measures for the two groups separately. See the Appendix for details on the Performance Index calculation. In order to address the shortcomings of prior studies, we wanted to do much more than either having a comprehensive, statewide dataset, or using more valid and reliable outcome measures such as the standardized and challenging[4] New York State common core assessments. As noted earlier, most prior librarian effect research had typically examined statistical differences in outcomes between those schools with and without a librarian, without taking into account prior background conditions, demographics and factors that research has shown would also have an effect on student achievement. To address this problem we conducted structural equation modeling (path analysis) separately for each of these 16 academic outcome measures, with each of the outcome measures as the dependent variable, while controlling for the following student and school characteristics or factors (independent variables).

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[4] See the National Assessment of Educational Progress equating with New York State Grade 4 and 8 ELA and Math Assessments at **http://nationsreportcard.gov/reading_math_2013**

Table 2: Background Controlling Variables Used in all the Structural Equation Models

      Prior Academic Achievement—(Prior Year)
      (NYS ELA/Math Used with ELA/Math Outcomes and Regents with Regents Outcomes)
- NYS ELA Performance Index for ELA (2011-12) Grades 3 to 8
- NYS Math Performance Index for Math (2011-12) Grades 3 to 8
- NYS English Regents Performance Index (2011-12)
- NYS Integrated Algebra Performance Index (2011-12)

      Student School Demographics
- Percentage of female students in the Building
- Percentage of students formally identified with disabilities (SWD) in the building
- Percentage of students identified as limited English proficient in the building
- Percentage of students who were black or Hispanic in the building

      School Characteristics
- Enrollment
- Percentage of students in poverty (using free/reduced lunch surrogate)
- Percentage of disadvantages families based on census data (NYC models only)
- Percentage of discipline incidents per student in building in 2011-12
- Classification of school as being in "Good Standing" on AYP or not (0 or 1)
- Having a full-time or greater certified school librarian or not (0 or 1)

The results of the 16 models (reflecting each of the 16 different outcome variables shown in Table 1 above), including the controls for prior academic, student demographics and school variables list above in Table 2 as controlling factors or covariates, show the following results for public school buildings with at least a full-time certified librarian, as compared with those without at least a full-time school librarian:

- Higher, statistically significant grades 3 to 8 2012-13 ELA Performance Index Scores in NYC ($p < .001$)
- Higher, statistically significant grades 3 to 8 2012-13 ELA Performance Index Scores in ROS ($p < .001$)
- Higher, statistically significant grades 3 to 8 change in ELA Performance Index Scores from 2011-12 to 2013 in NYC ($p < .001$)
- Higher, statistically significant grades 3 to 8 change in ELA Performance Index Scores from 2011-12 to 2013 in ROS ($p < .001$)
- Higher, statistically significant change in Regents English 2012-13 Performance Index Scores in NYC ($p < .05$)
- Higher, statistically significant Change in Regents English Performance Index Scores from 2011-12 to 2013 in NYC ($p < .05$)

The differences for full-time certified school librarians were NOT statistically significant for any of the math assessments in either NYC or ROS (NYS Math 2012-13 or Change in NYS Math 2011-

12 to 2012-13), or for the Regents 2012-13 Performance Index for Integrated Algebra or the Change in Regents Integrated Algebra Performance Index from 2011-12 to 2012-13 in either NYS or ROS. In addition, for the rest of the state public schools (ROS) there was no statistically significant difference between schools with and without at least a full time certified school librarian in terms of the Regents English 2012-13 Performance Index Scores or the Change in Regents English Performance Index Scores from 2011-12 to 2013.

In all our models including those that did not reflect a significant certified school librarian effect, prior school-level ELA and math scores (or Regents English or Integrated Algebra depending on the model) along with the percentage of free/reduced lunch students in the school, all showed strong (and statistically significant) effects on the outcome variable of the model, after controlling for the other variables. This is consistent with most other research, and in fact was part of the reason why these variables were included, despite the fact that in almost all other librarian impact research these variables were not all included. We do need to note that the full-time certified school librarian effect if we can call it that, while statistically significant in the six models highlighted, is relatively small in terms of the amount of variance in student achievement that it explains—in the range of 0.5% to 1% of the total variance in student achievement (outcome variable). This effect is far outweighed in size by the effects of prior achievement scores and free/reduced lunch percentages (poverty), however it is still statistically significant for the six outcome variables highlighted.

Educational researchers examining the educational effect of classroom teachers on student achievement argue that only a small percentage in the variability of student achievement can actually be accounted for by the classroom teacher, and that a substantial portion of achievement is attributable to other factors, especially economic and family related factors. In fact, the American Statistical Association (2014) formally stated that the range of teacher effects after controlling for other factors, was in the range of 1% to 14% of total variance explained. Nie et al (2004) posit 7% to 21%. In any case, it is clear that there are many factors inside and outside the school to which student achievement can be attributed. Considering this, we would expect that even a highly effective school librarian's influence on student achievement, even if that effect is substantial for some students and classes, would be diffused across the entire building and likely be relatively small and therefore difficult to measure. The small effect size is not, therefore, surprising.

Limitations of the Study

Like any research study, there are many caveats and limitations to keep in mind as you review the result. We are using a wide range of data measures that try, albeit imperfectly, to reflect a very complex underlying reality. For one, our outcome measures are the standardized assessments reflected in the NYS assessment program. Whether the NYS ELA or Math Assessments or Regents English or Regents Integrated Algebra exams are the best fit for determining librarian impact (or teacher impact) is debatable. However, they are probably the best measures available across all public schools. We would point out that because we are using the 2012-13 common core assessments, we did not have to address the approximately 20% parent opt out problem for NY State assessment data in 2014-15 as a part of our data, since the 2012-13 school year was prior to any real issues with opting out. Also as noted earlier, the BEDS data is self-reported by buildings, along with many of the other variables. Despite the limitations of the BEDS and other NYSED data, they reflect one of the most comprehensive data sets on schools available anywhere in the United States.

While our goal is to identify causal factors that effect student achievement, given that we are using observational data, it is also very difficult to attribute an effect with absolute certainty to any set of variables. Making causal inferences with observational data within a structural equation model (SEM) is made difficult by the omitted variable problem, that is that there may be a spurious factor that remains unmeasured and outside of the model. If there are systematic processes that are not random, but are not measured/reflected in our model, those processes could influence the outcome. Within SEM when we introduce a time ordered sequence we extend our ability to examine and determine causal relationships between variables. Our models incorporate many more covariates than any other research in the school library arena, all in an attempt to identify and control for the factors that impact student achievement. Whether any key variables have been missed will remain an open question and will always be a consideration in our on-going research.

APPENDIX

The Performance Index (PI) measure is an accountability measure that allows the results of the Grade 3 to 8 New York State assessments (which are not truly vertically scaled) to be combined across grade levels for comparison of school performance. It also provides a way for school buildings that differ in their grade level configurations to be compared relative to their ELA or math results.

The PI can take a value from 100 to 200, and indicates how the school performed on a particular assessment. A value of 100 indicates that none (0%) of the students were at level 3 or level 4 performance, while a value of 150 indicates that 50% of the students were at proficiency or above (level 3 or 4). The PI is calculated using the performance levels of students as follows: ((# of students at Level 1 + # of students at Level 2 + # of students at Level 3 + # of students at Level 4 + # of students at Level 3 + # of students at Level 4)/ (total # of students))*100.

http://data.nysed.gov/glossary.php?report=accountability

Radlick, M., & Stefl-Mabry, J. (2015, April 16-20). *Finally –Convincing Evidence for the Impact of School Librarians?* Paper presented at the American Educational Research Association, Chicago, IL.