The Effect of “Learning Landscapes” Playgrounds on Third Grade Mathematics Achievement

Kristen Davidson

Abstract

The “Learning Landscapes” initiative is a project that has been revitalizing many of the Denver Public Schools’ playgrounds over the last five years. This study examines the relationship between the presence and age of a Learning Landscapes playground and changes in achievement in mathematics as measured by the third grade state examination over the period 2005 to 2007. When all schools were included in the study, negative effects were observed for schools with Learning Landscapes playgrounds. However, schools with less than the median Free and Reduced Lunch status fared much better than those at or above the median. Similar effects were seen for schools based on English Language Learner status.
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Background

The Learning Landscape (LL) Alliance is a partnership between Denver Public Schools and the College of Architecture and Planning at the University of Colorado Denver that develops revitalized playgrounds for the city’s elementary schools. To date, fifty-three LL playgrounds have been completed, with twenty-seven more to be constructed within the next few years. Funding of on average $430,000 per playground (the most extensive in the country) is provided by city taxes dedicated through bond initiatives, the school district, volunteers, private foundations and businesses, and community members (Learning Landscape Alliance [LLA], http://thunder1.cudenver.edu/cye/lla/home.html, 2007).

In an independent study conducted by The Center for Research Strategies, LL playgrounds were associated with increased community involvement as well as decreased instances of behavioral problems, vandalism, and injuries (LLA, 2007). Research is ongoing to examine changes in rates of physical activity as well as qualitative differences in the socialization of children. An area that has not yet been studied is the effect of these playgrounds on academic achievement.

Lois Brink, the Principal Investigator of the project, claims, “Our goal is to build landscapes so we can demonstrate that you can improve learning, you can improve test scores by the environment kids are in, and that includes their playground” (LLA, http://thunder1.cudenver.edu/cye/lla/lla_ucd.html, 2007). A study of academic achievement gains for a similar playground development initiative in Boston used survey results, and emphasized that research to date on the achievement effects of playgrounds has not utilized test scores. Moreover, while improved achievement related to both the school environment and outdoor learning has been documented, the effect of playgrounds has not been isolated (Education Development Center & Boston Schoolyard Funders Collaborative, 2000).

Purpose and Research Questions

The purpose of this study is to examine the relationship between the presence of a new LL playground and changes in 3rd grade CSAP-Math proficiency over the period 2005 to 2007. Because of possible volatility in test scores from year to year, scores will be examined for a two-year period. As the CSAP-Math was not given below fifth grade before 2005, the 2005 to 2007 time period examines the 3rd grade CSAP-Math proficiency levels for the first three assessments of this kind in the state. Furthermore, under NCLB, schools in Colorado are required to report the percentage of students “partially proficient and higher” (including proficient and advanced) to the federal government. Therefore, the effect of LL playgrounds on the percentage of students with partially proficient and higher 3rd grade CSAP-Math scores will be estimated for all schools, as well as for schools with different family income levels and native languages as measured by Free and Reduced Lunch (FRL) and English Language Learner (ELL) populations.

The study will focus on two questions:
1. How do changes in achievement on the 3rd grade CSAP-Math from 2005 to 2007 relate to the presence and age of an LL playground for the schools in this study?
2. After controlling for the FRL and ELL status of schools, to what extent does the association between LL status and 3rd grade CSAP-Math improvement change?
Methods

School level population size, rates of proficiency on the CSAP-Math, and percentages of students qualifying for FRL were obtained from the Colorado Department of Education [CDE] (2007) database. Populations of ELLs for individual schools were extracted from The Piton Foundation (2007). Denver Public Schools Construction Services provided a list of all district schools categorized by year of LL playground completion (T. Garner, personal communication, December 3, 2007).

From this data, changes in 3rd grade CSAP-Math proficiency were calculated from 2005 to 2007 for each school. Within the Denver Public School district, only elementary schools (K-5 or K-6) that had either received a LL playground or had no new playground were included in the analysis. All K-8 schools and elementary schools whose playground was improved through other means were excluded from the sample. This resulted in a sample of 67 schools, in which 40 had completed LL playgrounds, and 27 had no new playground.

After an initial analysis on the effects of LL playground status on math achievement, I divided schools based on median FRL population size. This was used as a proxy for economic status, as FRL designates the percent of families whose income levels are at or below 185% of the poverty line (Federal Register, March 15, 2006). I then divided the entire sample of schools by median ELL population size, as a proxy for English language proficiency. These categorizations were only used in the concluding analyses, in which I estimated the effect of new playgrounds on math achievement while controlling for FRL and ELL, separately.

Results

I assessed the comparability of schools in the sample for different years of LL playground completion based on school population size, percent FRL, percent ELL, and the average percent partially proficient and higher on the 3rd grade CSAP-Math during the 2005 to 2007 period. As the distributions of these characteristics for the entire sample are skewed, medians were used as a basis for comparison. The similarity of the schools in this analysis is shown in Table 1 on page 3.

As playgrounds were completed during the summer, and CSAP exams are taken in the spring, the first year of CSAP scores for a school with a LL playground are observed in the year following the “year of LL playground completion” in Table 1. Therefore, ages for playgrounds were determined for the 2007 CSAP-Math by subtracting the year of completion. In this way, a playground that was completed in 2006 was designated as “Year 1” for 2007, a completion date of 2005 translated to “Year 2” in 2007, and so on. As only 7 schools had ages of 4 or 5 in 2007, and both of these groups indicate an established LL playground prior to the 2005 to 2007 time period, I grouped these schools into “Years 4-5.”

For these age groups, I calculated the gain in percent partially proficient and higher on the 3rd grade CSAP-Math from 2005 to 2007 as the difference in percentage points for these two years. I then estimated effects by the difference in gains for schools with LL playgrounds compared to those with no new playgrounds. The effects on 3rd grade CSAP-Math 2005 to 2007 gain for schools with LL playgrounds are negative for all age groups. (See Table 2 on page 3.) Moreover, all LL age groups performed worse than the district average loss of 0.4 percentage points and the state average loss of 0.1 percentage points in this area (CDE, 2007).
Table 1: Median School Characteristics by Year of LL Playground Completion.

<table>
<thead>
<tr>
<th>YEAR OF LL PLAYGROUND COMPLETION</th>
<th>N</th>
<th>SCHOOL SIZE</th>
<th>% FRL</th>
<th>% ELL</th>
<th>% PARTIALLY PROFICIENT &amp; HIGHER: AVERAGE FOR 2005-2007 TESTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007 or later</td>
<td>27</td>
<td>426</td>
<td>84</td>
<td>82</td>
<td>82.9</td>
</tr>
<tr>
<td>2006</td>
<td>6</td>
<td>370</td>
<td>90</td>
<td>89</td>
<td>80.4</td>
</tr>
<tr>
<td>2005</td>
<td>15</td>
<td>403</td>
<td>83</td>
<td>81</td>
<td>78.4</td>
</tr>
<tr>
<td>2004</td>
<td>12</td>
<td>382</td>
<td>85</td>
<td>81</td>
<td>81.5</td>
</tr>
<tr>
<td>2003</td>
<td>5</td>
<td>316</td>
<td>90</td>
<td>89</td>
<td>77.2</td>
</tr>
<tr>
<td>2002</td>
<td>2</td>
<td>494</td>
<td>89</td>
<td>86</td>
<td>81.0</td>
</tr>
</tbody>
</table>

Table 2: Effects for Percent Partially Proficient and Higher

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>27</td>
<td>82.7</td>
<td>82.6</td>
<td>82.7</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Year 1</td>
<td>6</td>
<td>81.8</td>
<td>78.5</td>
<td>81.2</td>
<td>-0.7</td>
<td>-0.6</td>
</tr>
<tr>
<td>Year 2</td>
<td>15</td>
<td>79.2</td>
<td>75.7</td>
<td>77.4</td>
<td>-1.8</td>
<td>-1.7</td>
</tr>
<tr>
<td>Year 3</td>
<td>12</td>
<td>79.2</td>
<td>81.8</td>
<td>74.8</td>
<td>-4.4</td>
<td>-4.3</td>
</tr>
<tr>
<td>Years 4-5</td>
<td>7</td>
<td>76.9</td>
<td>74.9</td>
<td>76.0</td>
<td>-0.9</td>
<td>-0.8</td>
</tr>
</tbody>
</table>

A scatterplot of the change in percent partially proficient and higher shows an interesting trend. There is a general upward shift in this area for schools with LL playgrounds, especially in the first year, with the exception of two outliers, marked by “◆” in Figure 1 on page 4.

The year 1 outlier had a high percentage of students partially proficient and higher in 2005 (93%) relative to its FRL status in that year (96.1%). The regression equation for these variables, \( \hat{y} = 98.6 - 0.25x \), predicts a value of 74.6% partially proficient and higher for a school with 96.1% FRL. The school’s value of 93% is 1.5 r.m.s. errors above the predicted value, and the subsequent decrease in performance could be explained by regression to the mean. Likewise, the year 3 outlier had a very low percentage of students partially proficient and higher in 2007 (45%) relative to its FRL status in that year (81.2%). The regression equation for these variables, \( \hat{y} = 96.8 - 0.24x \), predicts a value of 86% partially proficient and higher for a school with 81.2% FRL. The school’s value of 45% is 3.2 r.m.s. errors below the predicted value, and points to the possibility of other factors contributing to a sharp decrease from 2005 to 2007.
Since FRL status is negatively correlated with the mean 3rd grade CSAP-Math percent partially proficient and higher for 2005 to 2007 (r = -0.55)\(^1\), I divided schools into groups by the median FRL of 85.7% for all schools in the sample. I then estimated effects for changes in 3rd grade CSAP-Math achievement for schools with (1) less than 85.7% FRL and (2) equal to or greater than 85.7% FRL.

These effects show quite different results for schools with different FRL status. Schools with less than 85.7% FRL show positive effects for schools with LL playgrounds for all ages. However, schools with 85.7% or greater FRL show negative effects for all LL playground ages. (See Table 3.)

Likewise, since ELL status was also negatively correlated with the mean 3rd grade CSAP-Math percent partially proficient and higher for 2005 to 2007 (r = -0.56)\(^2\), I divided schools into groups by the median ELL status of 83.1% for all schools in the sample. I then estimated effects for changes in CSAP-Math achievement for schools with (1) less than 83.1% ELL and (2) equal to or greater than 83.1% ELL.

These effects show similar results to schools divided by FRL status. Schools with less than 83.1% ELL show positive effects for schools with LL playgrounds for all age groups, with no applicable schools in the fourth and fifth years. For schools with 83.1% or greater ELLs, schools show negative effects for all LL playground ages. (See Table 4 on page 5.)

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\(^1\) It should be noted that since this is an ecological correlation, it likely overstates the association.

\(^2\) Again, this is an ecological correlation, and likely overstates the association.
Table 4: Effects Controlling for ELL Status

<table>
<thead>
<tr>
<th>ELL STATUS</th>
<th>LL PLAYGROUND AGE</th>
<th>N</th>
<th>% PARTIALLY PROFICIENT &amp; HIGHER GAIN</th>
<th>EFFECT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 83.1%</td>
<td>No new playground</td>
<td>15</td>
<td>-2.4</td>
<td></td>
</tr>
<tr>
<td>N = 33 schools</td>
<td>Year 1</td>
<td>2</td>
<td>2.9</td>
<td>5.3</td>
</tr>
<tr>
<td></td>
<td>Year 2</td>
<td>9</td>
<td>-1.2</td>
<td>1.2</td>
</tr>
<tr>
<td></td>
<td>Year 3</td>
<td>7</td>
<td>3.1</td>
<td>5.4</td>
</tr>
<tr>
<td></td>
<td>Years 4-5</td>
<td>0</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>All new LL playgrounds</td>
<td>18</td>
<td>0.2</td>
<td>2.6</td>
</tr>
<tr>
<td>83.1% or Greater</td>
<td>No new playground</td>
<td>12</td>
<td>2.6</td>
<td></td>
</tr>
<tr>
<td>N = 34 schools</td>
<td>Year 1</td>
<td>4</td>
<td>-2.4</td>
<td>-5.0</td>
</tr>
<tr>
<td></td>
<td>Year 2</td>
<td>6</td>
<td>-2.8</td>
<td>-5.4</td>
</tr>
<tr>
<td></td>
<td>Year 3</td>
<td>5</td>
<td>-14.9</td>
<td>-17.5</td>
</tr>
<tr>
<td></td>
<td>Years 4-5</td>
<td>7</td>
<td>-0.6</td>
<td>-3.2</td>
</tr>
<tr>
<td></td>
<td>All new LL playgrounds</td>
<td>22</td>
<td>-4.4</td>
<td>-7.0</td>
</tr>
</tbody>
</table>

Conclusion

When all schools were included in the study, negative effects were observed for schools with new LL playgrounds on 3rd grade achievement from 2005 to 2007 as measured by the percent partially proficient and higher on CSAP-Math exams. However, when FRL status was controlled, schools with less than the median FRL status fared much better than those at or above the median. For schools with less than 85.7% FRL, positive effects were seen for schools with LL playgrounds of all ages. For schools with 85.7% or greater FRL, all LL playground ages showed negative effects. Similar effects were seen when ELL status was controlled. Here, schools with less than the median of 83.1% ELLs showed positive effects for schools with LL playgrounds, while all LL schools with 83.1% or greater ELLs showed negative effects.

These results are limited by several factors. Potential confounding variables outside of the compounded effects of FRL and ELL populations are not controlled for in this study, such as pupil-teacher ratio, attendance rate, population stability, teacher characteristics, and type of school program. A follow-up study using multiple regression to control for these variables would better estimate the effects found here. Also, standardized test results have been questioned as achievement measures for schools with high FRL and ELL status.

Moreover, history is a significant threat to the validity of this analysis, as changes in school programs or funding related to the presence of LL playgrounds are not known. As an observational study, selection is also a concern. Playgrounds were first slated for schools in “focused” or lower socioeconomic neighborhoods, and were gradually granted to other schools depending on perceived need and progress in fundraising. It is therefore unclear what differences may characterize schools based on playground completion dates. Finally, the grouping of schools into playground ages as well as into two FRL and ELL categories ignores important differences within these groups and may challenge the construct validity of this investigation.

While explanation is beyond the scope of this study, it questions the ability for schools with very high FRL and ELL populations to overcome barriers to achievement. The positive effects observed for schools with less than the median FRL and ELL status indicate the potential impact of new playgrounds on 3rd grade CSAP-Math proficiency. It may be that schools with extremely high populations of FRL and ELLs do not show achievement gains due to the multiple and pronounced effects of confounding variables.
References


Syntax

1. To create Table 1: Characteristics of Schools by LL Playground Completion Year:
   
   SORT CASES BY YEAR_0.
   SPLIT FILE LAYERED BY YEAR_0.

   FREQUENCIES VARIABLES=FRL_MEAN CPPH_3_MEAN ELL_MEAN TOT_POP
   /FORMAT=NOTABLE
   /STATISTICS=STDDEV MEAN MEDIAN
   /ORDER=ANALYSIS.

2. For distribution (histogram) of mean percent partially proficient & higher from 2005-2007:
   
   SPLIT FILE OFF.
   GRAPH
       /HISTOGRAM=CPPH_3_MEAN.

3. To create Table 2: Effects for Percent Partially Proficient and Higher:
   
   SORT CASES BY AGE_CODE.
   SPLIT FILE LAYERED BY AGE_CODE.
   FREQUENCIES VARIABLES=CPPH_M3_05 CPPH_M3_06 CPPH_M3_07 CPPH_3_0507
   /FORMAT=NOTABLE
   /STATISTICS=STDDEV MEAN MEDIAN
   /FORMAT=DVALUE
   /ORDER=ANALYSIS.

4. To create Figure 1: Scatterplot of Change in Percent Partially Proficient and Higher by LL Playground Age:
   
   SPLIT FILE OFF.
   IGRAPH
       /VIEWNAME='Scatterplot'
       /X1=VAR(AGE_CODE) TYPE=SCALE
       /Y=VAR(CPPH_3_0507) TYPE=SCALE
       /COORDINATE=VERTICAL
       /FITLINE METHOD=REGRESSION LINEAR LINE=TOTAL SPIKE=OFF
       /YLENGTH=5.2
       /X1LENGTH=6.5
       /CHARTLOOK='NONE'

       /SCATTER COINCIDENT=NONE.

5. To create Table 3: Effects for Percent Partially Proficient and Higher Controlling for FRL:
   
   SORT CASES BY ID(A).
   SORT CASES BY FRL_CODE.
   SPLIT FILE LAYERED BY FRL_CODE.
   MEANS TABLES=CPPH_3_0507 BY AGE_CODE
       /CELLS MEAN COUNT STDDEV.
6. To create Table 4: Effects for Percent Partially Proficient and Higher Controlling for ELL:

SORT CASES BY ID(A).
SORT CASES BY ELL_CODE.
SPLIT FILE LAYERED BY ELL_CODE.
MEANS TABLES=CPPH_3_0507 BY AGE_CODE

/CELLS MEAN COUNT STDDEV.

7. To create regression equation for percent partially proficient and higher on mean FRL in 2005:

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/MISSING LISTWISE
/STATISTICS COEFF OUTS R ANOVA
/Criteria=PIN(.05) POUT(.10)
/NOORIGIN
/DEPENDENT CPPH_M3_05

/METHOD=ENTER FRL_05.

8. To create regression equation for percent partially proficient and higher on mean FRL in 2007:

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/STATISTICS COEFF OUTS R ANOVA
/Criteria=PIN(.05) POUT(.10)
/NOORIGIN
/DEPENDENT CPPH_M3_07

/METHOD=ENTER FRL_07.

9. To correlate mean FRL with mean percent partially proficient and higher:

CORRELATIONS
/VARIABLES=FRL_MEAN CPPH_3_MEAN
/PRINT=TWOTAIL NOSIG

/MISSING=PAIRWISE.

10. To correlate mean ELL with mean percent partially proficient and higher:

CORRELATIONS
/VARIABLES=ELL_MEAN CPPH_3_MEAN
/PRINT=TWOTAIL NOSIG

/MISSING=PAIRWISE.