

An Analysis of the Relationship Between Participation in Bricks 4 Kidz Programs and Growth in Math and Science Learning

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Analysis and white paper prepared by
Bryan Shelly, Ph.D.
Founder and President
Advanced Education Measurement
aemkids.com

Bricks 4 Kidz and Math and Science Learning

Bricks 4 Kidz (B4K) contracted AEM to better understand possible connections between its programs and math and science learning in elementary-aged children. This report provides a description of AEM’s research design and results.

B4K provides LEGO®-based S.T.E.M. (science, technology, engineering, and mathematics) instruction to children ages 3-13 at over 400 worldwide franchises. B4K franchises use “specially designed project kits, theme-based models...[and] proprietary model plans” (Bricks 4 Kidz 2016).

AEM evaluated 2 of B4K’s 6 programs: hour-long workshops (subsequently referred to as “workshops”) and six-week after-school programs that meet once a week for roughly 90 minutes (“after-school programs”). AEM’s study analyzed the following two hypotheses:

1. Students who participate in B4K workshops and after-school programs demonstrate growth in targeted math and science skills.
2. Students who participate in B4K after-school programs demonstrate increases in psychological traits strongly associated with future mathematics and science achievement.¹

AEM’s study examined workshops for three age groups (6, 8, and 10) and after-school programs for two grade ranges (grades K-2 and grades 3-5). AEM used existing B4K lesson plans as the basis for a pre/posttest design. For workshops, children took a four-item pre/posttest at the beginning and end of the hour-long session that measured understanding of key curriculum concepts. For after-school programs, children took a seven-item pre/posttest at the beginning of the first and last/sixth sessions. 3 items on the after-school test measured understanding of key curriculum concepts, and 4 Likert-scaled items measured psychological traits associated with future math and science achievement. 702 total children at 6 participating franchises completed both tests and are included in this analysis.

Table 1 contains summary information on this study’s design and administration.

¹ B4K and AEM judged that reported changes in attitudes after one one-hour session would be unreliable indicators of lasting attitudinal changes and therefore did not measure changes in attitudes towards math and science of workshop participants.

Results

Table 2 presents the average number of correct responses for all program participants on both the pretest and posttest. The average of correct student responses increased for all five groups and both programs. For workshops, the average student answered between .45 and 1.76 more items correct on the posttest. These increases represent between an 11.3 and 44.0 percent higher score on the posttest.² For after-school programs, the average student answered between .25 and .32 more curriculum items correctly on the posttest. These increases represent between a 6.3 and 10.7 percent higher score on the curriculum items on the posttest. All increases described in Table 2 are statistically significant.³

To understand the magnitude of the changes described in Table 2, Table 3 compares children's improvement in both B4K programs to improvement in a random sampling of five previous studies that used a pretest/posttest design to measure student learning.⁴ The rate of improvement for children in B4K workshops exceeds all other studies considered. The rate of improvement for children in B4K after-school programs is less than 3 of 5 other studies considered, but compares favorably to the two studies that measured student learning over a similar length of time.

Table 4 divides all participating children by whether they performed better, the same, or worse on the posttest versus the pretest. For workshops, 69.9 percent of children answered at least one more item right on the posttest, 21.3 percent of children performed the same on both tests, and 8.8 percent of children performed better on the pretest. For after-school programs, 40.1 percent of children improved on the posttest, 40.5 percent performed the same on both tests, and 19.4 percent of children performed better on the pretest.

Table 5 presents results from the four Likert-scaled items on attitudes related to future math and science achievement asked of after-school program participants. B4K participants found math slightly less "scary" on the posttest than on the pretest, and the effect is statistically significant at conventionally accepted level ($p \leq .05$). Changes on the other three attitude items were not statistically significant.

² Percent improvement is a function of the average improvement in total correct answers on the posttest divided by the total number of content items.

³ Sig 2-tailed test with hypothesized mean difference of 0, $p \leq .05$.

⁴ Results from first five studies of a Google Scholar search for "pretest posttest student improvement" sources from 2001-present are included in Table 3. All five studies described here appeared in peer-reviewed academic journals and have been cited by at least 100 other studies.

Discussion

Further research is needed to fully determine whether participation in B4K programs causes growth in targeted math and science skills. Factors omitted from this analysis such as student, family, and school characteristics will influence how well students performed on both the pretest and posttest. However, correlation is a necessary (but not sufficient) condition to prove causation, and this study has demonstrated a strong relationship between participation in B4K programs and improvement on the study's measure of math and science. This study provides limited evidence that participation in B4K improves student attitudes consistent with future math and science achievement. AEM is confident that the information contained in this report represents the best information to date for concerned parties to understand the effect of participation in B4K programs.

Tables

Table 1: Summary of AEM analysis of Bricks 4 Kidz programs

Workshops

<i>Age range of workshop participants</i>	<i>Number of B4K students included in analysis</i>	<i>Length of program</i>	<i>Number of pretest/posttest items</i>	<i>Concepts tested</i>	<i>Pretest administered</i>	<i>Posttest administered</i>
6	132	One hour	4	Mastery of specified curriculum	Beginning of session	End of session
8	176					
10	157					

After-school programs

<i>Grade span of program participants</i>	<i>Number of B4K students included in analysis</i>	<i>Length of B4K program</i>	<i>Number of pretest/posttest items</i>	<i>Concepts tested</i>	<i>Pretest administered</i>	<i>Posttest administered</i>
K-2	156	6 one-hour sessions	7	Mastery of specified curriculum; affinity for and fear of math and science	Beginning of first session	Beginning of last/sixth session
3-5	81					

Table 2: Average number of correct responses on pre and posttest for Bricks 4 Kidz program participants

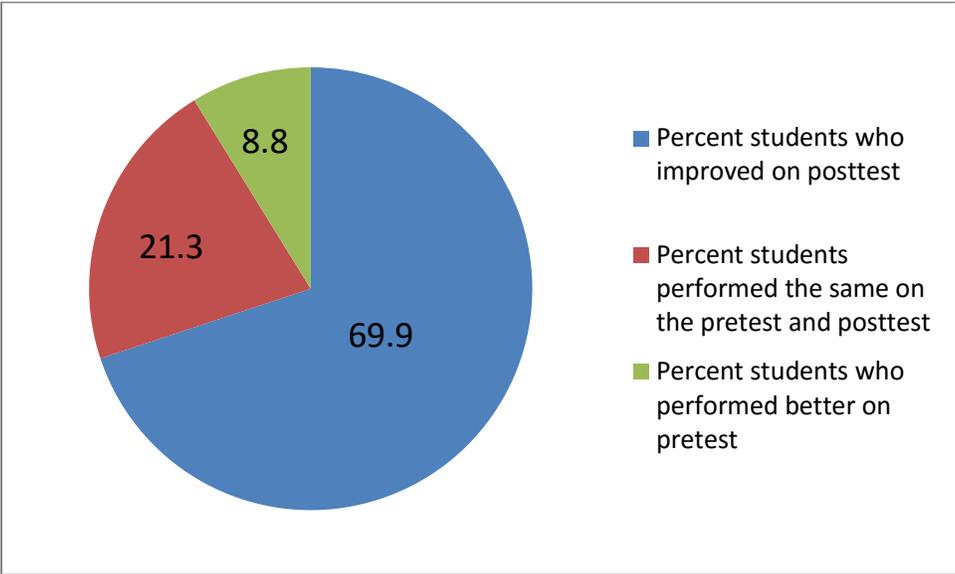
	<i>Hour-Long Workshops (4 Content Items)</i>				<i>Six-Week After-School Programs (3 Content Items)</i>		
	<i>Age 6</i>	<i>Age 8</i>	<i>Age 10</i>	<i>All hour-long workshops</i>	<i>K-2</i>	<i>3-5</i>	<i>All six-week after-school programs</i>
<i>Pretest average</i>	1.20	1.05	0.78	1.00	1.69	0.90	1.42
<i>Posttest average</i>	1.64	2.53	2.54	2.28	2.01	1.15	1.72
<i>Average improvement on posttest</i>	0.45	1.48	1.76	1.28	0.32	0.25	0.30
<i>Average percent improvement on posttest</i>	11.3	37.0	44.0	32.0	10.7	6.3	10.0
<i>Sample Size</i>	132	176	157	465	156	81	237
<i>P(T<=t) two-tail</i>	0.00	0.00	0.00	0.00	0.00	0.04	0.00

Table 3: Average student improvement on posttest: B4K programs versus other studies

<i>Study</i>	<i>In-school or after-school program?</i>	<i>Level of students in program</i>	<i>Sample size</i>	<i>Length of program</i>	<i>Improvement on posttest</i>
Bricks 4 Kidz in-school workshops	In school	Grades K, 2, & 4	465	One hour	32%
(Brigman and Campbell 2003)	In school	Grades 5-9	180	One academic year	22%
(Caffrey et al. 2005)	In school	Nursing school	32	One academic year	20%
(Papastergiou 2009)	In school	Grades 9-12	88	Four hours	20%
Bricks 4 Kidz after-school programs	After school	Grades K-5	237	Six weeks	9%
(Fishman et al. 2003)	In school	Grades 6-8	312	8-10 weeks	7%
(Vaughn 2002)	In school	Grade 5	21	5 weeks	6.8%

Table 4: Percent of students performed better, the same, or worse on posttest versus pretest

Workshops



After-School Programs

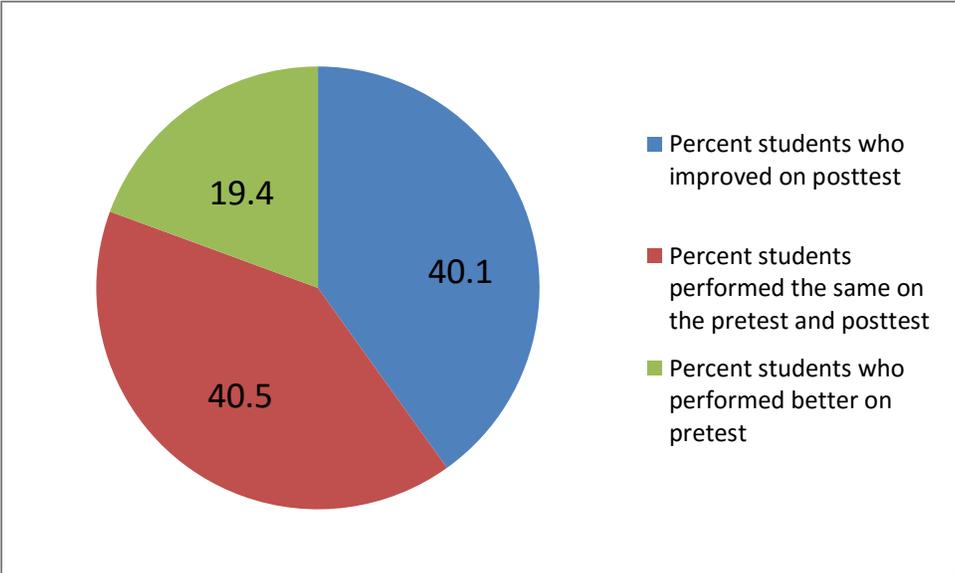


Table 5: Average Bricks 4 Kidz after-school program student responses measuring affinity for math and science

	<i>How much do you like math?</i>	<i>How scary is math to you?</i>	<i>How much do you like science?</i>	<i>How scary is science to you?</i>
<i>Response on pretest</i>	1.68	2.67	1.44	2.71
<i>Response on posttest</i>	1.64	2.75	1.40	2.66
<i>Average improvement on posttest</i>	.04	.08*	-.04	-.05
<i>P(T<=t) two-tail</i>	0.42	0.04	0.40	0.30
<i>N</i>	237	237	237	237

* $p \leq .05$

Possible responses for “How much do you like ____?” items

- “A lot” (coded 1)
- “A little (coded 2)
- “I do not like _____.” (coded 3)

Possible responses for “How scary is ____ to you?” items

- “Very scary” (coded 1)
- “A little scary” (coded 2)
- “Not scary” (coded 3)

Works Cited

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6922 Dartmouth Avenue
Richmond, VA 23226
609-915-1326
aemkids.com