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Can Formal–Informal Collaborations Improve Science Literacy in Urban Middle Schools? The Impact of Urban Advantage

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Introduction

This brief presents findings from a study on Urban Advantage (UA), a collaboration between the American Museum of Natural History (AMNH), other New York City informal science institutions, and the New York City Department of Education (NYCDOE) to improve the science literacy of NYC public school students. The following analysis draws on a rich longitudinal database, containing student- and school-level data for all NYC public schools and students from 2004-05 to 2009-10. Results indicate that these collaborations can have a positive impact on student achievement and science learning.

The findings from this study are especially timely given that U.S. students consistently show low levels of achievement on tests of science literacy. On the 2009 National Assessment of Education Progress (NAEP), only 63% of eighth-graders demonstrated "partial mastery of the knowledge

Key Findings

- Students at UA schools outperform students at non-UA schools. In 2005-06, the second year of the program, 44.2% of students at UA schools are proficient on the Intermediate Level Science Test (ILS) exam, compared to 40.5% at non-UA schools. In 2008-09, 55.5% of students at UA schools are proficient, compared to 46.2% of students at non-UA schools.
- The magnitude of the difference between students at UA and non-UA schools increases over time. Little change is seen in student performance on ELA or math for eighth-grade students, suggesting the effect is not merely reflecting coincident overall school improvement.
- UA has grown from 35 schools and 63 teachers in 2005 to 174 schools and 386 teachers in 2010 and serves approximately 35% of middle schools and 20% of students in NYC.
- UA schools are similar to other NYC schools serving eighth graders, despite larger enrollments.

and skills that are fundamental for proficient work" in science (National Center for Education Statistics, 2011). For urban school districts like New York City (NYC), the NAEP scores are even more alarming: only 38% of NYC eighth-graders scored at or above this level of basic proficiency, with even lower scores for black and Hispanic students (24% and 26%, respectively) (National Center for Education Statistics, 2011).

Given these low levels of science knowledge, programs such as UA are important for re-envisioning the approaches, leadership, and methodologies for educating American children in science. Within the formal education sector, researchers have pointed to the importance of supporting students' college and career readiness by more closely aligning K-12 education standards with the knowledge and skills they will need to succeed in introductory college-level science courses (The College Board, 2009). At the same time, informal science education institutions seeking to support the science efforts of school systems that have increasingly focused their attention on reading/language arts and math have been identified as critical participants, "premised on the notion that their emphasis on phenomena-rich, learning-driven interactions with science resonates with the notion of inquiry underlying K-12 science education reform" (National Research Council, 2009).

What is Urban Advantage?

The primary goal of Urban Advantage (UA) is to improve student understanding of scientific inquiry as defined in the New York State Core Curriculum. UA was initiated in 2004 and is administered by the Gottesman Center for Science Teaching and Learning at the AMNH working in collaboration with several informal science institutions, including the Brooklyn Botanic Garden, New York Botanical Garden, New York Hall of Science, Queens Botanical Garden, Staten Island Zoological Society, the Wildlife Conservation Society's Bronx Zoo and New York Aquarium, and the NYCDOE. The name "Urban Advantage" reflects the partners' belief that it is an advantage to live in an urban setting with so many science-rich cultural institutions and nature facilities. UA differs fundamentally from traditional museum-to-school collaborations as it provides a hybrid model for civic engagement where the resources of institutions are selected, designed, and shaped by the specific alignment to the science curriculum of NYC's middle schools.

UA provides teachers with 48 hours of professional development over eight days during their first year of the program and an additional 10 hours beginning in year two. Professional development emphasizes authentic hands-on learning experiences in science, the nature of scientific work, specific science topics, and the essential features of inquiry (NRC, 2000) in the form of long-term science investigations, referred to as science exit projects in NYC. After choosing a UA partner institution to work with, teachers learn how to plan effective field trips, embed resources in instruction, use UA-provided equipment and resources, teach students the components of experimental design, and to develop scientific explanations based on claims, evidence, and reasoning to help students complete the science exit projects. UA also provides free admission to all partner institutions in the form of vouchers to facilitate individual, class, and family field trips. Participating schools also receive transportation funds for weekend family trips, which are organized by each school's parent coordinator[1].

Table 1: Growth of Urban Advantage from 2005 to 2010

	2005 Y1	2006 Y2	2007 Y3	2008 Y4	2009 Y5	2010 Y6
# UA Students	5,500	18,722	21,016	27,541	24,793	37,582
# UA Schools	31	111	129	156	147	174
# UA Teachers	62	195	210	256	257	386

As shown in Table 1, UA has substantially expanded since its first year of operation. It now serves schools in every community school and NYC council district. In its first year of operation, UA worked with 63 teachers in 35 schools and reached 5500 students. By year 4 UA was working with 257 teachers and 27,541 students in 155 schools; in the current school year (2010-11), the program serves 156 schools, 371 teachers, and 37,822 students in grades 6-8, representing 35% of all middle schools with eighth-grade and 20% of students in grades 6-8.

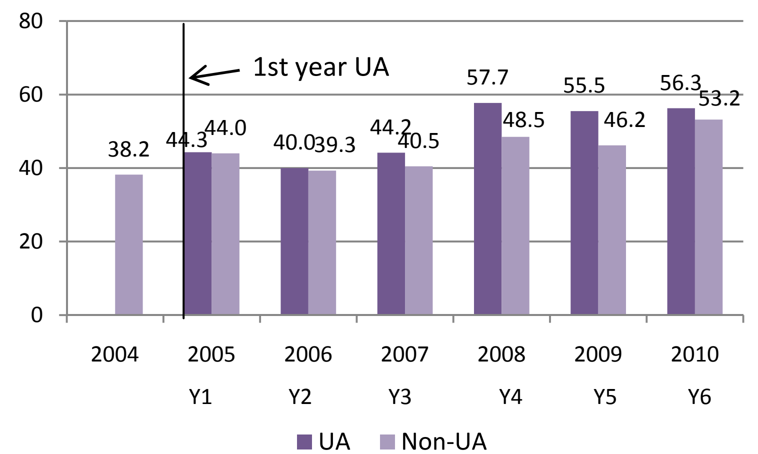
UA schools are, in many respects, quite similar to other New York City schools serving eighth-graders. The one consistent difference between UA and non-UA schools is size. On average, UA schools are larger than non-UA schools. And across UA schools, as with city schools as a whole, there is much variation. UA serves students in schools that vary in size, demographics, and poverty status.

[1] Parent coordinators are members of schools' administrative teams and work with school staff, parent associations, and community groups to increase parent involvement in schools.

Results

Figure 1 shows the distribution of eighth-grade students scoring in levels 3 or 4 on the New York State (NYS) Intermediate-Level Science (ILS) Test from years 2003-04 (one year prior to UA) through 2009-10. Prior to UA, less than 40% of NYC eighth-graders were proficient in science in 2003-04, considerably less than the NYS average of 86%.

Figure 1. Percent of Students in Each Year who Meet Standards on eighth Grade ILS by UA and Non-UA Schools



In the first two years of UA, no significant differences are found in performance between students at UA and non-UA schools. However, in the third year differences begin to emerge. In 2006-07, the difference between the two groups grows to 3.7% as students at UA schools begin to outperform students at non-UA schools on the ILS exam, 44.2% to 40.5%. The difference between the two groups expands in years four and five to over 9%, when over 55% of UA students are proficient, compared to less than 50% of students at non-UA schools.

This finding is consistent with the literature of school improvement who believe that three years is the minimum amount of time needed to see results (Fullan & Stiegelbauer). By the third year of implementation (2007-08), UA had a more-developed and stronger program that included not only professional development but also a set of materials and resources to help teachers in the classroom.

It is possible that selection may play a significant role in the success of the program. That is, is there a difference in the schools that choose to participate in UA? Schools and teachers that choose to enter or remain in UA may have higher performing students to begin with or students who differ in other ways that may influence performance than the schools that choose not to participate in UA.

While the number of schools that participate in UA differs in each year, Table 2 shows that schools that enter UA are no different than those which do not in the year prior to joining. None of the demographic characteristics of students or the percent of students who are proficient in ELA, mathematics or science show statistically significant differences between UA schools and non-UA schools. The only statistically significant difference is for total enrollment in the first year of UA when the schools were significantly larger than those not entering UA.

Table 2: Mean Characteristics of UA and Non-UA Schools, Year Prior to Joining UA

	2004		2005		2006		2007		2008		2009	
	UA	Non-UA	UA	Non-UA	UA	Non-UA	UA	Non-UA	UA	Non-UA	UA	Non-UA
N of Schools	31	289	61	291	43	366	42	244	7	227	24	238
Total Enrollment	**1079**	**851**	851	784	611	586	580	539	738	667	519	621
	(434)	**(468)**	(500)	(439)	(426)	(425)	(439)	(390)	(647)	(373)	(328)	(375)
% Black	41.84	36.47	34.05	38.67	37.65	38.95	36.95	39.41	33.89	38.52	35.74	38.17
	(28.1)	(28.1)	(26.2)	(29.5)	(29.3)	(28.9)	(29.4)	(29.3)	(34.0)	(29.3)	(26.7)	(29.4)
% Hispanic	35.10	39.91	42.81	39.56	42.21	40.45	43.27	40.48	35.56	41.18	46.87	40.74
	(22.9)	(25.4)	(26.3)	(25.7)	(27.5)	(26.0)	(25.4)	(26.4)	(23.2)	(26.4)	(23.0)	(25.9)
% Asian/Other	13.26	9.67	10.20	9.42	7.16	8.77	10.32	8.61	12.56	9.14	7.13	10.37
	(19.6)	(12.1)	(12.9)	(13.0)	(12.0)	(13.3)	(14.2)	(13.4)	(14.5)	(14.1)	(9.7)	(14.9)
% White	9.82	13.96	12.94	12.34	12.53	11.18	8.87	10.95	17.78	10.71	10.48	10.64
	(18.2)	(19.6)	(19.3)	(19.1)	(22.1)	(18.0)	(13.3)	(18.5)	(19.1)	(18.0)	(14.4)	(17.7)
% ELL	10.26	10.60	11.68	10.59	10.79	10.80	11.29	10.74	9.67	11.23	10.56	12.02
	(7.8)	(10.6)	(10.7)	(10.4)	(9.9)	(11.1)	(10.2)	(12.7)	(4.2)	(11.7)	(10.1)	(11.7)
% Free Lunch	75.37	71.10	69.20	68.66	63.30	69.90	64.76	66.29	55.89	66.30	72.48	69.98
	(21.8)	(23.5)	(21.7)	(22.5)	(23.1)	(23.3)	(30.2)	(27.1)	(31.5)	(25.8)	(15.8)	(20.4)
% Prof. ELA	33.17	39.42	50.94	46.94	36.11	40.14	42.32	42.37	58.41	48.75	43.17	41.71
	(16.6)	(20.5)	(19.9)	(21.3)	(20.4)	(21.3)	(19.1)	(21.6)	(18.9)	(21.6)	(22.1)	(20.2)
% Prof. Math	38.10	43.63	48.49	45.07	36.34	43.08	53.53	50.71	73.27	62.42	48.64	48.77
	(17.4)	(20.6)	(21.7)	(22.3)	(23.2)	(22.2)	(21.2)	(23.6)	(18.7)	(23.5)	(25.6)	(22.3)
% Prof. Science	38.23	45.03	46.88	45.17	36.61	39.52	43.00	42.05	47.57	50.16	45.34	47.86
	(20.9)	(24.8)	(23.9)	(23.8)	(23.0)	(24.0)	(19.6)	(24.6)	(27.7)	(22.7)	(28.4)	(23.0)

Standard deviations are in parentheses
Bold indicates differences are statistically significant at .05 level or less
% Proficient is the percent scoring in levels 3 or 4

As shown in Table 3, controlling for the year prior to becoming UA, we find that UA students, on average, do 0.041 standard deviations better than students at non-UA schools (Model 1). If we control for the first year that schools are in UA, students at UA schools do even better in the years post UA entry, with those students performing at .056 standard deviations higher than students at non-UA schools (Model 2). While black and Hispanic students do worse compared to white students in science, we do find that UA has some impact in reducing the disparity for black students (Model 3). We find that black students at UA schools, in general, score 0.066 standard deviations better than black students at non-UA students. Asian students, who generally outperform white students, do perform even better if they are in UA schools. On the other hand, female students perform worse when compared to male students, and it appears that, in general, female students at UA schools do significantly worse than their non-UA counterparts (β=-0.033).

The same analyses were completed using ELA and math as the dependent variables; this is a check to see if, in general, students at UA schools are higher performing than students at non-UA schools. No significant differences are found for math or ELA. This provides evidence that UA has significant impacts for students on the eighth-grade science exam.

Table 3: OLS Regression, Urban Advantage, 2005 through 2010

	Science		Math	ELA	Science
	Model 1	Model 2	Model 2	Model 2	Model 3
	β/se	β/se	β/se	β/se	b/se
Year Prior UA	0.002	0.011	0.011	-0.001	0.010
	(0.018)	(0.021)	(0.024)	(0.017)	(0.021)
UA in Any Year	**0.041***				
	(0.016)				
Year Ent. UA		0.044	0.036	0.026	0.013
		(0.024)	(0.027)	(0.021)	(0.038)
Years Post UA		**0.056***	0.014	0.022	0.030
		(0.028)	(0.031)	(0.023)	(0.037)
Black	-0.397***	-0.397***	-0.408***	-0.375***	-0.411***
	(0.017)	(0.017)	(0.022)	(0.023)	(0.017)
Hispanic	-0.226***	-0.226***	-0.270***	-0.275***	-0.235***
	(0.015)	(0.015)	(0.020)	(0.021)	(0.015)
Asian	0.162***	0.162***	0.407***	0.064**	0.145***
	(0.019)	(0.019)	(0.027)	(0.022)	(0.021)
Female	-0.072***	-0.072***	0.027***	0.194***	-0.062***
	(0.005)	(0.005)	(0.004)	(0.004)	(0.005)
UA*White					0.012
					(0.028)
UA*Black					**0.062***
					(0.030)
UA*Hispanic					0.042
					(0.027)
UA*Asian					**0.066***
					(0.032)
UA*Female					**-0.033*****
					(0.008)
Constant	41.407***	45.897***	21.546*	4.157	44.951***
	(6.584)	(8.097)	(8.614)	(7.134)	(8.153)
School FE	YES	YES	YES	YES	YES
R-Square	0.35	0.35	0.33	0.32	0.35
N	401270	401270	425820	409572	401270

(1) * p<0.05, ** p<0.01, *** p<0.001
(2) Robust clustered standard errors in parentheses
(3) LEP, Special Education, Poverty, and Year dummies not shown

Summary

Our study provides the first estimates of the impact of Urban Advantage on eighth-grade test scores for NYC students. In short, we find evidence that UA improves performance in science: student performance on the NYS science exam increases with the implementation of UA and the magnitude of the difference between UA and non-UA schools increases over time. Little change in seen in student performance on ELA or math for eighth-grade students, suggesting the effect is not merely reflecting coincident overall school improvement. Exploratory subgroup analyses suggest the impact is largest for black students, and less successful for girls than boys.

Recent publications (NRC, 2005; 2007) indicate that, if students are to understand science, they must have opportunities to do science. At its core, scientific inquiry involves conducting investigations by posing scientifically oriented questions, prioritizing evidence, and developing logical explanations. Local, state, national, and international science standards all recommend inquiry as a method to approach science instruction (American Association for the Advancement of Science, 1993; National Research Council, 1996; New York State Education Department, 2010; New York City Department of Education, 2011). However, much of the current science instruction in schools in the United States does not utilize inquiry, instead taking a more simplistic approach (National Research Council, 2009).

While schools traditionally have not utilized inquiry methods, many informal science institutions embrace this form of instruction. Informal science institutions are also believed to help make science learning “personally relevant and rewarding” (National Research Council, 2009, p. 1). Although schools and informal science institutions approach science differently and play different roles in students’ lives in regards to science instruction, there is a growing body of literature that points to the benefits of collaboration between formal and informal science institutions. For example, a National Research Council report (2009) on learning science in informal environments showed that informal science learning experiences impact children’s interest in science; in the report, the NRC recommended a collaboration between formal and informal education institutions to increase students’ science learning. Research shows that informal science institutions can be effective resources for hands-on science learning for students and increased science pedagogical content knowledge for teachers (Aquino, Kelly, & Bayne, 2010). Other studies have shown that in many circumstances, field trips can be a beneficial addition to science instruction, though they have often been underused as teaching tools (DeWitt & Storksdieck, 2008).

The results of this analysis give support to the call by the National Research Council and others for an increased role of informal institutions in science learning both for students and teachers. However, these institutions cannot work on their own. Strong partnerships between the institutions within each community and between the institution and the school district(s) in which they work (and in most cases, consistent funding sources) must be in place to enable these programs to grow and flourish and to provide students with the resources they need to develop as scientists.

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