Exploratory Evidence on the Factors that Relate to Elementary School Science Learning Gains Among English Language Learners

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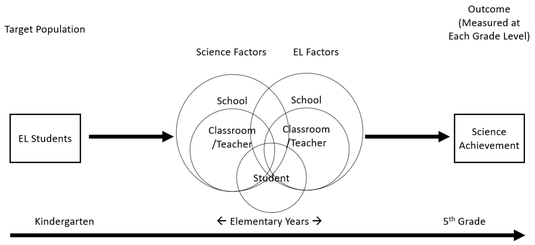
Background and Research Question

- Prior work has found that students whose primary home language is not English tend to score around half a standard deviation lower in science through elementary and middle school than those whose primary home language is English (Morgan et al., 2016).
- What is more, for Hispanic and Asian students, EL status appears to be the most significant predictor of why their elementary school achievement lags White student performance to a greater degree in science than in mathematics or reading (Curran & Kitchin, 2019).

- **Research question:**
  - How do science test performance trajectories vary across and within EL student groups in elementary school?
  - How do access to school, teacher, and classroom level science and EL inputs vary across and within EL student groups in elementary school?
  - Which school, teacher, and classroom level science and EL inputs are predictive of greater science test performance gains in elementary school?

Theoretical Framework



Data and Methodology

- Early Childhood Longitudinal Study of 2010-11 (ECLS-K:2011), a nationally representative longitudinal study of kindergartners in 2010-11 through fifth grade in 2015-16.
- School, teacher, and parent surveys alongside standardized science assessments of students.

- Focused on the following groups:
  - 1) Whether a non-English language was spoken in the home – our definition of an ML (parent report);
  - 2) Whether a non-English language spoken at home was the primary language at home (parent report);
  - 3) Whether students received formal ELL services at school (teacher report); and
  - 4) Whether students' non-English language was Spanish or a less common language (parent report)

Results

How do science test performance trajectories vary across and within EL student groups in elementary school?

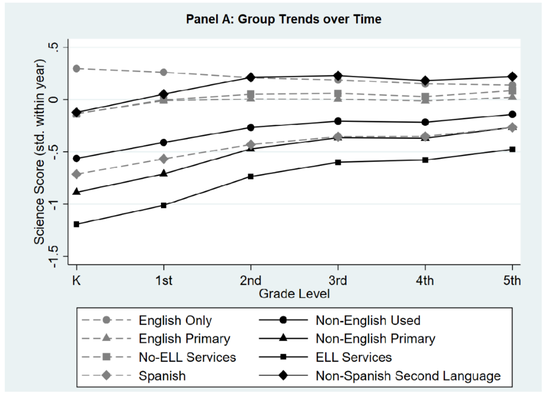


Figure 1. Elementary Science Learning Trajectories of ML Students

Source: US DOE, NCES, Early Childhood Longitudinal Study of 2010-11, Previously unpublished calculations.

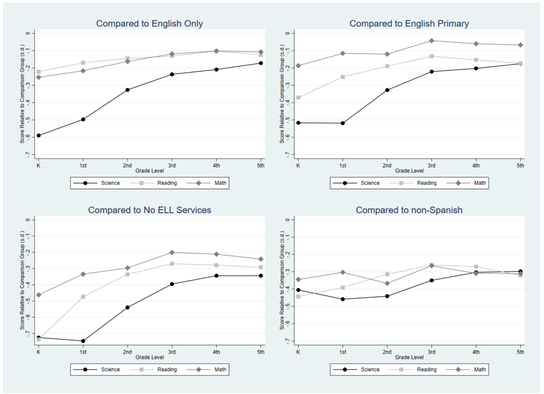


Figure 2. Elementary Science Learning Trajectories of ML Students Relative to Reading and Mathematics

Source: US DOE, NCES, Early Childhood Longitudinal Study of 2010-11, Previously unpublished calculations.

How do access to school, teacher, and classroom level science and EL inputs vary across and within EL student groups in elementary school?

	Full Sample	English Only	Non-English	English Primary	Non-English Primary	English Native	Non-English Native	ELL Services	No-ELL Services	Spanish	Non-Spanish	
Instructional Inputs												
Lessons or projects on science (mins/week)	119.8	117.0	128.7	125.5	131.4	124.4	132.6	138.9	122.6	136.4	108.0	e
	(4.151)	(4.287)	(7.279)	(5.777)	(9.219)	(6.364)	(9.096)	(11.852)	(5.562)	(9.333)	(4.308)	
Taught… (days/month)												
on ordering objects	6.558	6.370	7.160	6.889	7.373	6.875	7.406	7.421	6.985	7.417	6.487	a,e
	(0.150)	(0.179)	(0.189)	(0.227)	(0.240)	(0.242)	(0.258)	(0.294)	(0.215)	(0.232)	(0.260)	
on sorting objects into subgroups	7.579	7.356	8.293	8.196	8.373	8.083	8.523	8.548	8.139	8.406	8.019	a
	(0.187)	(0.209)	(0.215)	(0.275)	(0.268)	(0.299)	(0.247)	(0.338)	(0.268)	(0.232)	(0.449)	
on identifying relative quantity	11.29	11.26	11.37	11.59	11.21	11.43	11.39	11.45	11.31	11.69	10.57	e
	(0.237)	(0.277)	(0.242)	(0.285)	(0.282)	(0.290)	(0.297)	(0.367)	(0.271)	(0.275)	(0.375)	
on reading simple graphs	9.369	9.584	8.685	8.931	8.481	8.960	8.588	8.461	8.839	8.516	9.123	a
	(0.247)	(0.285)	(0.253)	(0.274)	(0.338)	(0.315)	(0.351)	(0.409)	(0.290)	(0.285)	(0.398)	
on performing data collection and graphing	7.718	7.858	7.271	7.452	7.142	7.411	7.277	7.173	7.324	7.182	7.539	
	(0.198)	(0.228)	(0.234)	(0.294)	(0.299)	(0.299)	(0.298)	(0.346)	(0.273)	(0.258)	(0.413)	
on estimating quantities	5.469	5.396	5.702	5.773	5.667	5.612	5.776	5.736	5.684	5.759	5.569	
	(0.155)	(0.172)	(0.201)	(0.275)	(0.268)	(0.281)	(0.275)	(0.332)	(0.258)	(0.258)	(0.320)	
Taught… (yes/no)												
human body in my class	0.659	0.652	0.680	0.678	0.681	0.678	0.689	0.702	0.664	0.691	0.650	
	(0.019)	(0.021)	(0.023)	(0.027)	(0.027)	(0.029)	(0.026)	(0.032)	(0.025)	(0.027)	(0.028)	
plants and animals in my class	0.956	0.952	0.969	0.973	0.966	0.972	0.966	0.967	0.969	0.968	0.971	
	(0.008)	(0.009)	(0.005)	(0.007)	(0.007)	(0.007)	(0.006)	(0.007)	(0.006)	(0.006)	(0.008)	
dinosaurs and fossils in my class	0.317	0.325	0.289	0.308	0.273	0.331	0.260	0.245	0.314	0.282	0.306	
	(0.021)	(0.024)	(0.022)	(0.027)	(0.024)	(0.030)	(0.024)	(0.027)	(0.027)	(0.022)	(0.029)	
solar system and space in my class	0.403	0.409	0.382	0.389	0.374	0.403	0.369	0.349	0.407	0.386	0.368	
	(0.022)	(0.024)	(0.028)	(0.032)	(0.031)	(0.033)	(0.031)	(0.034)	(0.031)	(0.030)	(0.040)	
weather in my class	0.982	0.982	0.983	0.989	0.979	0.987	0.981	0.975	0.988	0.982	0.988	
	(0.004)	(0.005)	(0.006)	(0.003)	(0.008)	(0.004)	(0.008)	(0.012)	(0.004)	(0.007)	(0.004)	
to know and measure temperature in my class	0.685	0.696	0.650	0.672	0.634	0.673	0.636	0.630	0.667	0.645	0.664	
	(0.019)	(0.022)	(0.021)	(0.023)	(0.025)	(0.025)	(0.027)	(0.032)	(0.022)	(0.026)	(0.030)	
water in my class	0.678	0.671	0.698	0.716	0.685	0.700	0.696	0.696	0.702	0.714	0.656	
	(0.018)	(0.020)	(0.020)	(0.026)	(0.023)	(0.027)	(0.022)	(0.029)	(0.021)	(0.025)	(0.032)	
sound in my class	0.425	0.428	0.414	0.422	0.409	0.437	0.403	0.413	0.413	0.432	0.368	
	(0.018)	(0.019)	(0.025)	(0.030)	(0.028)	(0.027)	(0.030)	(0.038)	(0.024)	(0.028)	(0.031)	
light in my class	0.390	0.387	0.398	0.414	0.387	0.427	0.377	0.395	0.403	0.422	0.332	e
	(0.019)	(0.021)	(0.027)	(0.030)	(0.029)	(0.029)	(0.030)	(0.039)	(0.026)	(0.028)	(0.033)	
magnetism and electricity in my class	0.410	0.419	0.381	0.419	0.351	0.408	0.364	0.386	0.380	0.391	0.354	
	(0.022)	(0.024)	(0.025)	(0.030)	(0.026)	(0.028)	(0.028)	(0.034)	(0.025)	(0.026)	(0.038)	
machines and motors in my class	0.212	0.205	0.235	0.244	0.229	0.256	0.224	0.246	0.229	0.258	0.174	e
	(0.015)	(0.016)	(0.023)	(0.030)	(0.023)	(0.031)	(0.023)	(0.031)	(0.025)	(0.028)	(0.028)	
tools and their uses in my class	0.516	0.503	0.557	0.586	0.534	0.578	0.542	0.554	0.556	0.593	0.461	e
	(0.019)	(0.020)	(0.024)	(0.032)	(0.024)	(0.030)	(0.026)	(0.029)	(0.029)	(0.025)	(0.037)	
health, safety, nutrition, or hygiene in my class	0.925	0.929	0.914	0.925	0.904	0.927	0.908	0.910	0.915	0.907	0.933	
	(0.010)	(0.011)	(0.012)	(0.011)	(0.014)	(0.012)	(0.016)	(0.017)	(0.013)	(0.014)	(0.015)	
ecology in my class	0.544	0.543	0.548	0.561	0.538	0.561	0.539	0.541	0.551	0.531	0.596	
	(0.014)	(0.015)	(0.019)	(0.021)	(0.023)	(0.023)	(0.022)	(0.025)	(0.023)	(0.024)	(0.030)	
scientific method in my class	0.436	0.429	0.459	0.491	0.434	0.483	0.442	0.455	0.460	0.456	0.468	
	(0.017)	(0.019)	(0.023)	(0.027)	(0.026)	(0.028)	(0.025)	(0.029)	(0.024)	(0.026)	(0.037)	
lab skills in my class	0.231	0.227	0.246	0.258	0.237	0.246	0.249	0.284	0.224	0.252	0.229	
	(0.014)	(0.016)	(0.018)	(0.021)	(0.027)	(0.021)	(0.027)	(0.036)	(0.018)	(0.023)	(0.031)	
communicating ideas in science in my class	0.641	0.636	0.655	0.681	0.633	0.663	0.653	0.673	0.642	0.662	0.633	
	(0.016)	(0.018)	(0.019)	(0.020)	(0.025)	(0.022)	(0.025)	(0.027)	(0.020)	(0.024)	(0.026)	
relevance of science to society in my class	0.491	0.484	0.513	0.537	0.495	0.516	0.513	0.530	0.503	0.526	0.482	
	(0.016)	(0.018)	(0.021)	(0.020)	(0.030)	(0.023)	(0.028)	(0.035)	(0.018)	(0.026)	(0.034)	
Using Science to teach Reading (times/month)	3.058	3.052	3.077	3.116	3.044	3.143	3.043	3.071	3.086	3.072	3.092	
	(0.029)	(0.030)	(0.043)	(0.039)	(0.052)	(0.038)	(0.059)	(0.065)	(0.040)	(0.052)	(0.045)	
Material Inputs												
Use science equipment to teach (times/month)	5.203	5.241	5.084	4.987	5.157	5.111	5.088	5.260	4.976	5.237	4.666	
	(0.205)	(0.225)	(0.285)	(0.276)	(0.358)	(0.275)	(0.382)	(0.505)	(0.258)	(0.344)	(0.263)	
Students worked with measuring instruments (times/month)	3.036	3.037	3.032	2.957	3.098	3.093	2.994	3.020	3.034	3.121	2.801	
	(0.120)	(0.134)	(0.161)	(0.174)	(0.197)	(0.212)	(0.178)	(0.230)	(0.177)	(0.184)	(0.219)	
Students worked on using measuring instruments accurately (times/month)	3.618	3.602	3.671	3.467	3.834	3.506	3.792	3.824	3.521	3.823	3.280	
	(0.148)	(0.166)	(0.200)	(0.227)	(0.252)	(0.240)	(0.247)	(0.281)	(0.219)	(0.240)	(0.255)	
Personnel Inputs												
Teacher Taken a College Course in Teaching Science (yes/no)	0.825	0.836	0.790	0.790	0.788	0.770	0.802	0.783	0.792	0.781	0.811	
	(0.013)	(0.011)	(0.030)	(0.032)	(0.031)	(0.032)	(0.031)	(0.035)	(0.030)	(0.038)	(0.024)	
Observations	**11990**	**8950**	**3040**	**1340**	**1680**	**1190**	**1730**	**1120**	**1850**	**1950**	**1090**	

Source: US DOE, NCES, Early Childhood Longitudinal Study of 2010-11, Previously unpublished calculations.

Results

Which school, teacher, and classroom level science and EL inputs are predictive of greater science test performance gains in elementary school?

Table 3. Coefficients and standard errors from regression models predicting standardized science achievement from ML indicators

	No Controls	Individual Covariates	Family Covariates	School Covariates	Reading Test Score	All Covariates
Panel A						
Non-English Used at Home in K	-0.556***	-0.382***	-0.397***	-0.434***	-0.434***	-0.267***
	(0.0507)	(0.0463)	(0.0408)	(0.0360)	(0.0401)	(0.0339)
Grade Level	0.425***	0.425***	0.420***	0.423***	0.156***	0.183***
	(0.0030)	(0.0030)	(0.0029)	(0.0029)	(0.0055)	(0.0054)
Interaction	0.0870***	0.0870***	0.0880***	0.0881***	0.0748***	0.0763***
	(0.0063)	(0.0063)	(0.0064)	(0.0066)	(0.0072)	(0.0069)
Observations	28968	28968	28968	28968	28968	28968
Panel B						
Non-English Primary at Home in K	-0.524***	-0.438***	-0.334***	-0.408***	-0.330***	-0.221***
	(0.0681)	(0.0715)	(0.0750)	(0.0736)	(0.0485)	(0.0499)
Grade Level	0.467***	0.467***	0.464***	0.468***	0.190***	0.212***
	(0.0064)	(0.0064)	(0.0069)	(0.0064)	(0.0141)	(0.0126)
Interaction	0.0789***	0.0789***	0.0786***	0.0772***	0.0547***	0.0557***
	(0.0119)	(0.0119)	(0.0125)	(0.0121)	(0.0099)	(0.0101)
Observations	6102	6102	6102	6102	6102	6102
Panel C						
ELL Services in K	-0.748***	-0.675***	-0.577***	-0.645***	-0.389***	-0.305***
	(0.0660)	(0.0668)	(0.0671)	(0.0703)	(0.0538)	(0.0548)
Grade Level	0.475***	0.475***	0.472***	0.475***	0.221***	0.236***
	(0.0053)	(0.0053)	(0.0055)	(0.0057)	(0.0100)	(0.0090)
Interaction	0.0930***	0.0930***	0.0921***	0.0909***	0.0440***	0.0459***
	(0.0109)	(0.0109)	(0.0111)	(0.0119)	(0.0112)	(0.0111)
Observations	6102	6102	6102	6102	6102	6102
Panel D						
Spanish Used at Home in K	-0.454***	-0.109	-0.176*	-0.249***	-0.196**	0.0217
	(0.0751)	(0.1090)	(0.0743)	(0.0727)	(0.0634)	(0.0592)
Grade Level	0.489***	0.489***	0.488***	0.490***	0.211***	0.233***
	(0.0099)	(0.0099)	(0.0110)	(0.0098)	(0.0139)	(0.0120)
Interaction	0.0313**	0.0313**	0.0279*	0.0287*	0.0126	0.0119
	(0.0111)	(0.0111)	(0.0122)	(0.0112)	(0.0126)	(0.0126)
Observations	6100	6100	6100	6100	6100	6100

Note. Standard errors in parentheses. * p<0.05; ** p<0.01; *** p<0.001. Source: US DOE, NCES, Early Childhood Longitudinal Study of 2010-11, Previously unpublished tabulations.

Summary

- Elementary science test score trajectories vary as much across ML subgroups as they do between MLs and non-MLs.
- There are differences in test score gaps in science compared to math and reading, though not for all subgroups.
- MLs who speak a language other than Spanish close the science test score gap by the end of elementary school.
- Science inputs measured in the ECLS are relatively evenly distributed across MLs, non-MLs, and ML subgroups. Linguistic supports are not.

Acknowledgements

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