

Effects of Dual-Language Immersion Programs on Student Achievement: Evidence from Lottery Data

Online-Only Technical Appendix

Table of Contents

Figure A1. Immersion Program Logic Model	2
Table A1. Coefficients (and standard errors) for immersion effects on the dependent variables of interest, using full-sample, intent-to-treat, and instrumental variable models	3
Table A2. Main effect and interaction coefficients and net treatment effect estimates for two-way versus one-way programs	4
Table A3. Main effect and interaction coefficients and net treatment effect estimates for Spanish versus other immersion programs	5
Table A4. Main effect and interaction coefficients and net treatment effects for native English speakers versus native speakers of other languages	6
Table A5. Main effect coefficients, interaction coefficients, and net treatment effects for students whose native language differs from the partner language of the first-choice immersion program, versus those whose native language matches it	7
Table A6. Instrumental variables analysis of classroom characteristics that may mediate treatment effects in randomized sample	8

Figure A1. Immersion Program Logic Model

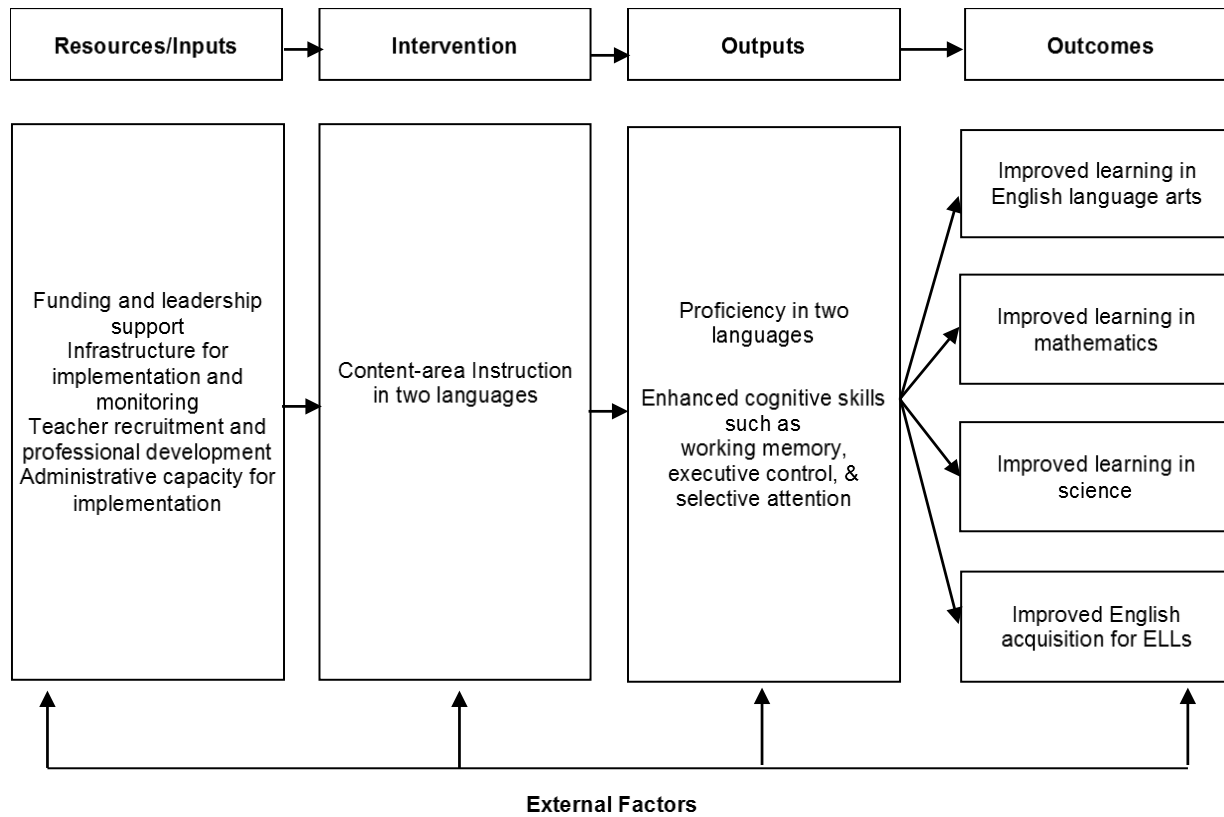


Table A1. Coefficients (and standard errors) for immersion effects on the dependent variables of interest, using full-sample, intent-to-treat, and instrumental variable models

Grade	Reading			Mathematics			Science		EL Classification		
	Full Samp	ITT	IV	Full Samp	ITT	IV	Full Samp	ITT	Full Samp	ITT	IV
1									0.023*** (0.004)	0.012 (0.009)	0.024 (0.019)
2									0.022*** (0.004)	0.014 (0.009)	0.030 (0.019)
3	0.095*** (0.020)	0.085~ (0.049)	0.188~ (0.103)	0.117*** (0.021)	0.026 (0.053)	0.066 (0.108)			0.026*** (0.004)	0.012 (0.009)	0.024 (0.019)
4	0.153*** (0.022)	0.073 (0.052)	0.17 (0.113)	0.269*** (0.022)	0.103~ (0.056)	0.222~ (0.118)			0.019*** (0.004)	-0.010 (0.010)	-0.019 (0.021)
5	0.202*** (0.023)	0.132* (0.055)	0.284* (0.118)	0.298*** (0.024)	0.079 (0.060)	0.176 (0.123)	0.136*** (0.026)	0.087 (0.065)	0 (0.005)	-0.004 (0.011)	-0.007 (0.023)
6	0.190*** (0.025)	0.094 (0.062)	0.213 (0.134)	0.263*** (0.026)	0.044 (0.066)	0.106 (0.140)			-0.012* (0.006)	-0.029* (0.013)	-0.057* (0.027)
7	0.157*** (0.029)	0.076 (0.068)	0.175 (0.155)	0.268*** (0.030)	0.02 (0.073)	0.049 (0.161)			-0.011 (0.007)	-0.037* (0.015)	-0.080* (0.033)
8	0.192*** (0.034)	0.221** (0.079)	0.510** (0.185)	0.313*** (0.035)	0.122 (0.085)	0.28 (0.190)	0.267*** (0.039)	0.124 (0.097)	-0.006 (0.009)	-0.014 (0.018)	-0.032 (0.041)
Observations	70,586	4,608	4,608	70,730	4,632	4,632	16,518	1,059	126,139	8,805	8,805
Students	21,057	1,451	1,451	21,034	1,447	1,447	12,622	822	25,189	1,625	1,625

~p<.10 * p<.05 **p<.01 ***p<.001

Note: The sample size does not permit IV estimation for science scores.

Table A2. Main effect and interaction coefficients and net treatment effect estimates for two-way versus one-way programs

Grade	Reading			Mathematics			Science			EL Classification		
	ITT (for Two-way)	ITT* One-way	Net ITT Effect for One-way	ITT (for Two-way)	ITT* One-way	Net ITT Effect for One-way	ITT (for Two-way)	ITT* One-way	Net ITT Effect for One-way	ITT (for Two-way)	ITT* One-way	Net ITT Effect for One-way
1										0.029~ (0.015)	-0.029 (0.019)	0
2										0.02 (0.015)	-0.011 (0.019)	0.009
3	0.106 (0.080)	-0.032 (0.101)	0.074	0.105 (0.087)	-0.128 (0.109)	-0.023				0.017 (0.015)	-0.011 (0.019)	0.006
4	0.064 (0.085)	0.016 (0.107)	0.08	0.206* (0.091)	-0.167 (0.116)	0.039				-0.014 (0.016)	0.001 (0.021)	-0.013
5	0.163~ (0.091)	-0.046 (0.114)	0.117	-0.005 (0.097)	0.127 (0.123)	0.122	0.129 (0.106)	-0.066 (0.133)	0.063	-0.023 (0.018)	0.028 (0.023)	0.005
6	0.092 (0.098)	0 (0.126)	0.092	0.137 (0.105)	-0.139 (0.135)	-0.002				-0.079*** (0.020)	0.104*** (0.027)	0.025
7	0.059 (0.105)	0.031 (0.139)	0.09	0.045 (0.112)	0.006 (0.148)	0.051				-0.053* (0.023)	0.056~ (0.030)	0.003
8	0.178 (0.122)	0.077 (0.161)	0.255	0.045 (0.130)	0.156 (0.171)	0.201	0.134 (0.148)	-0.014 (0.195)	0.12	-0.014 (0.028)	0.01 (0.037)	-0.004
Obs		4,608			4,632			1,059			8,805	
Students		1,451			1,447			822			1,625	

~p<.10 * p<.05 **p<.01 ***p<.001

Note: "Net effects" column estimates are the sums of the immersion and immersion-by-category coefficients, representing the total estimated ITT effect for the category in the interaction term. We do not show significance stars for the net effects, because they are calculated from the default and interaction coefficient columns. If the interaction coefficients (middle column of each set) are not statistically significant, then the estimated treatment effects for the category in the interaction term cannot be said to differ from the main effect in the left column of the outcome set.

Table A3. Main effect and interaction coefficients and net treatment effect estimates for Spanish versus other immersion programs

Grade	Reading			Mathematics			Science			EL Classification		
	ITT (for Spanish)	ITT*Other Languages	Net ITT Effect for Other Languages	ITT (for Spanish)	ITT*Other Languages	Net ITT Effect for Other Languages	ITT (for Spanish)	ITT*Other Languages	Net ITT Effect for Other Languages	ITT (for Spanish)	ITT*Other Languages	Net ITT Effect for Other Languages
1										0.023*	-0.047*	-0.024
										(0.011)	(0.019)	
2										0.017	-0.021	-0.004
										(0.011)	(0.019)	
3	0.069	0.055	0.124	-0.032	0.167	0.135				0.015	-0.012	0.003
	(0.059)	(0.104)		(0.064)	(0.113)					(0.011)	(0.020)	
4	0.09	-0.066	0.024	0.126~	-0.076	0.05				-0.007	0.008	0.001
	(0.063)	(0.114)		(0.068)	(0.123)					(0.012)	(0.023)	
5	0.145*	-0.055	0.09	-0.003	0.218~	0.215	0.079	0.003	0.082	-0.018	0.100***	0.082
	(0.066)	(0.122)		(0.071)	(0.131)		(0.076)	(0.143)		(0.013)	(0.026)	
6	0.127~	-0.13	-0.003	0.071	-0.023	0.048				-0.071***	0.237***	0.166
	(0.073)	(0.140)		(0.078)	(0.150)					(0.015)	(0.032)	
7	0.075	0.023	0.098	0.002	0.108	0.11				-0.053**	0.125**	0.072
	(0.078)	(0.167)		(0.083)	(0.178)					(0.016)	(0.041)	
8	0.196*	0.027	0.223	0.164~	0.052	0.216	0.165	0.011	0.176	-0.021	0.031	0.01
	(0.091)	(0.201)		(0.097)	(0.213)		(0.109)	(0.246)		(0.020)	(0.051)	
Obs		4,608			4,632			1,059			8,805	
Students		1,451			1,447			822			1,625	

~p<.10 * p<.05 **p<.01 ***p<.001

See Table A2 note for interpretive information.

Table A4. Main effect and interaction coefficients and net treatment effects for native English speakers versus native speakers of other languages

Grade	Reading			Mathematics			Science			EL Classification		
	ITT (Native English)	ITT*Native Not English	Net ITT Effect for Native Not English	ITT (Native English)	ITT*Native Not English	Net ITT Effect for Native Not English	ITT (Native English)	ITT*Native Not English	Net ITT Effect for Native Not English	ITT (Native English)	ITT*Native Not English	Net ITT Effect for Native Not English
1										0.005 (0.009)	-0.006 (0.021)	-0.001
2										0.005 (0.009)	0.020 (0.021)	0.025
3	0.082 (0.053)	0.02 (0.120)	0.102	0.01 (0.058)	0.09 (0.130)	0.1				0.005 (0.009)	0.019 (0.021)	0.024
4	0.088 (0.057)	-0.071 (0.128)	0.017	0.07 (0.062)	0.146 (0.138)	0.216				0.005 (0.010)	-0.065** (0.023)	-0.060
5	0.148* (0.061)	-0.099 (0.136)	0.049	0.109~ (0.065)	-0.171 (0.146)	-0.062	0.087 (0.070)	0.001 (0.157)	0.088	0.006 (0.011)	-0.002 (0.024)	0.004
6	0.120~ (0.069)	-0.144 (0.148)	-0.024	0.051 (0.074)	-0.014 (0.159)	0.037				0.006 (0.013)	-0.072* (0.028)	-0.066
7	0.044 (0.076)	0.067 (0.163)	0.111	0.049 (0.081)	-0.114 (0.175)	-0.065				0.005 (0.015)	-0.059~ (0.032)	-0.054
8	0.214* (0.087)	0.033 (0.205)	0.247	0.196* (0.093)	-0.439* (0.219)	-0.243	0.135 (0.105)	-0.062 (0.244)	0.073	0.006 (0.017)	-0.058 (0.042)	-0.052
Obs Students		4,608 1,451			4,632 1,447			1,059 822			8,805 1,625	

~p<.10 * p<.05 **p<.01 ***p<.001

See Table A2 note for interpretive information.

Table A5. Main effect coefficients, interaction coefficients, and net treatment effects for students whose native language differs from the partner language of the first-choice immersion program, versus those whose native language matches it

Grade	Reading			Mathematics			Science			EL Classification		
	ITT (Native Lang Not Partner)	ITT*Native Lang Partner	Net ITT Effect for Native Lang Partner	ITT (Native Lang Not Partner)	ITT*Native Lang Partner	Net ITT Effect for Native Lang Partner	ITT (Native Lang Not Partner)	ITT*Native Lang Partner	Net ITT Effect for Native Lang Partner	ITT (Native Lang Not Partner)	ITT*Native Lang Partner	Net ITT Effect for Native Lang Partner
1										-0.002 (0.009)	0.063* (0.026)	0.060
2										0.003 (0.009)	0.057* (0.026)	0.059
3	0.073 (0.051)	0.132 (0.151)	0.205	0.013 (0.056)	0.106 (0.163)	0.119				0.002 (0.009)	0.057* (0.026)	0.058
4	0.074 (0.055)	0.012 (0.160)	0.086	0.061 (0.059)	0.327~ (0.173)	0.388				-0.011 (0.010)	-0.007 (0.029)	-0.019
5	0.126* (0.059)	0.056 (0.169)	0.182	0.101 (0.063)	-0.177 (0.182)	-0.076	0.094 (0.068)	-0.044 (0.199)	0.05	0.009 (0.011)	-0.071* (0.031)	-0.063
6	0.097 (0.066)	-0.037 (0.182)	0.06	0.055 (0.071)	-0.025 (0.196)	0.03				0.023~ (0.013)	-0.162*** (0.035)	-0.140
7	0.03 (0.073)	0.204 (0.195)	0.234	0.053 (0.079)	-0.156 (0.209)	-0.103				0.008 (0.015)	-0.067~ (0.039)	-0.060
8	0.222** (0.085)	0.027 (0.235)	0.249	0.179* (0.091)	-0.419~ (0.251)	-0.24	0.143 (0.104)	-0.114 (0.278)	0.029	-0.005 (0.018)	-0.064 (0.049)	-0.069
Obs		4,608			4,632			1,059			8,805	
Students		1,451			1,447			822			1,625	

~p<.10 * p<.05 **p<.01 ***p<.001

See Table A2 note for interpretive information.

Table A6. Instrumental variables analysis of classroom characteristics that may mediate treatment effects in randomized sample

Panel A. First-stage estimated effect of winning immersion lottery on class characteristics in 2012-13				
	First-stage outcomes	Coeff.	Std. Error	n
Proportion of students in class who are:	Subsidized-meal eligible	0.010	(0.013)	728
	English learner	0.018***	(0.005)	1,112
	Special education	-0.030***	(0.006)	1,112
	Talented & gifted	0.000	(0.009)	1,112
	Asian	-0.002	(0.006)	1,112
	Hispanic	0.065***	(0.009)	1,112
	Black	-0.010*	(0.005)	1,112
	White	-0.046***	(0.010)	1,112
	Teacher years of experience	-1.263*	(0.521)	1,076
	Teacher has advanced degree	-0.009	(0.027)	1,071
Teacher highly qualified under NCLB	-0.018~	(0.011)	1,033	
Students in classroom	-0.300	(0.295)	1,112	
Panel B. Second-stage estimated effects of instrumented classroom attributes on reading scores				
	Second-stage instrumented predictors	Coeff.	Std. Error	n
Proportion of students in class who are:	Subsidized-meal eligible	3.255	(3.428)	550
	English learner	3.096	(3.570)	847
	Special education	-1.946	(2.135)	847
	Talented & gifted	-18.624	(71.063)	847
	Asian	-10.335	(17.517)	847
	Hispanic	0.812	(0.899)	847
	Black	-8.341	(11.596)	847
	White	-1.340	(1.514)	847
	Teacher years of experience	-0.302	(0.683)	819
	Teacher has advanced degree	-5.504	(11.756)	814
Teacher highly qualified under NCLB	-14.645	(20.319)	779	
Students in classroom	-0.168	(0.269)	847	

~p<.10 * p<.05 **p<.01 ***p<.001

Note: Panel A represents first-stage estimates from instrumental variable models that include lottery strata fixed effects and individual covariates, as in Equation 4. Panel B represents the second-stage IV estimates, as specified in Equation 5.