



Supporting Online Material for

Teachers' Participation in Research Programs Improves Their Students' Achievement in Science

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Supporting Online Materials

<http://www.sciencemag.org>

Supplementary paragraphs 1 – 9.

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Supplementary paragraph 1 – Requirement for two summers of participation. CUSRP was the first, and remains one of the few, science research programs to require two summers of participation. We implemented this requirement for three reasons. First, we believed time on task was important. Subsequent research has shown that 80-120 hours of focused professional development is required for teachers to change classroom practices in ways that affect student performance (5, refs. S-1 – S-4). Second, we wanted teachers to gain a sense of the pace of research progress. While progress may be imperceptible in two months, it is generally evident when teachers return for a second summer. Third, as with high school and college students who work in Columbia University's labs each summer, teachers who enter knowing that high performance will be recognized by an invitation to return for a second summer are likely to invest more of themselves than teachers limited to a single summer. Similarly, faculty members likely make larger investments in teachers who are committed from the outset to return for a second summer.

Supplementary paragraph S-2. Professional development workshops. These weekly day-long exercises help teachers relate their research laboratory experiences to their goals as educators. They engage teachers in a professional learning community (9) that is a safe haven for open, unstructured, and unhurried discussion; an environment that regrettably is missing in many schools, and one which too few teachers have experienced. They provide weekly opportunities for teachers with different educational backgrounds and teaching philosophies from city and suburban, public, private and parochial, middle and high schools, to network with one another and to share research experiences and findings in seminars, poster sessions, and casual conversations. By these means, teachers gain experience in discussing science as a dynamic and human activity. They also enable second-year teachers to guide and support entering teachers, and to model the high standards expected of all CUSRP participants.

Supplementary paragraph S-3. Teacher selection criteria. Program Advisory Committee members select ~25 applicants annually for interview from an applicant pool of 30-60 teachers (6). Criteria for admission include: Greater than 3 years of teaching experience; undergraduate and/or graduate academic preparation in science sufficient to work in a Columbia University research laboratory, excellent professional recommendations; permanent or temporary NY or NJ teaching certificate (public school teachers only); tangible evidence of commitment to education, (e.g., implementing a new course), to students (e.g., sponsoring a science club), to scholarship (e.g., publishing a paper), and/or resourcefulness (e.g., obtaining a grant). Teaching a Regents

level course and/or participation in the student outcomes study is not a consideration in teacher selection. Over 90% of accepted teachers matriculate.

Supplementary paragraph S-4. Laboratory safety. In addition to the University's required hour-long introduction to laboratory safety (8), a member of the program's Advisory Committee conducts a day-long review of contemporary laboratory equipment and procedures for all entering teachers. This required group activity occurs on the program's opening day. Teachers working in laboratories or on projects involving human experimentation, infectious microorganisms, human or animal tissues, hazardous chemicals, recombinant DNA, radioactive materials, and or lasers receive additional training as required by university regulations (8).

Supplementary paragraph S-5. Laboratory assignments. Program Advisory Committee members nominate prospective faculty mentors from among Columbia faculty working in all fields of science represented at the University. The Program's Director contacts these prospective mentors to ascertain their willingness to host a teacher. Teachers indicate on their applications for program admission the field(s) of science in which they wish to work. This is further explored when they are interviewed for admission to the program. Teachers are generally notified of admission to the program in late April. Soon thereafter they are referred for an interview with faculty doing research in a field of interest to the teacher. At these interviews, faculty usually suggest a research project, introduce the teacher to the graduate student(s), post-doctoral fellow(s), and/or laboratory staff with whom the teacher will work most closely during the summer, and provide the teacher with background reading material about the proposed project. Over 80% of these interviews result in teacher placements. In the few instances in which the faculty member or teacher feels the referral is not suitable, the Program Director seeks and finds another placement. No teacher has failed to matriculate because an appropriate placement could not be found.

Supplementary paragraph S-6. Graduate student academic year support. The program pays graduate students \$200/month for 8 months during the academic year for consulting with teachers by telephone/e-mail for five hours/month and for spending one day/month at the teacher's school. There, they assist with classroom and laboratory exercises, and function as near-peer role models and counselors for students, most of whom have never met a near-peer preparing for a career in science.

Supplementary paragraph S-7. Teacher attrition.

Most of the attrition from the substantive study among the 95 NYC high school teachers otherwise eligible to participate in it (Table S-3) was not due to their departure from education or from classroom teaching (Table S-6). Eighty nine (94%) of these 95 teachers remained in education and 86 (91%) were still classroom teachers at the end of the fourth academic year following their entry into CUSRP, yielding rates of attrition from education and from classroom teaching among all 95 CUSRP participants of 1.6%/year and 2.4%/year, respectively. These rates are 2.6 to 5.3-fold lower than the 6.3%, 6.6% and 8.5% annual attrition rates for comparably experienced, science, or urban high school teachers, respectively (Table S-9).

Nine of the 12 public high school teachers (Table S-6) who left education did so 5 or more years after program entry. We calculate the overall teacher attrition rate at $12/95 = 12.6\%$ per 12 years = 1.05% per year.

Attrition from the substantive study among the 32 teachers who participated in it also was not due to their departure from education or classroom teaching (Table S-6). Aside from one teacher who took maternity beginning in the third academic year after CUSR entry, and two teachers who were promoted to Assistant Principal in the third year after CUSR entry, attrition from the study was due primarily to one of four conditions also found in the multi-site SWEPT study (10) that prevented 63 otherwise eligible teachers from participating in the present study. These four conditions were:

1. Reassignment to teach a non-Regents course. Each September a number of returning teachers were reassigned to teach courses other than the ones they taught in the previous year. Changes in school funding, union contract requirements, unanticipated influxes of students with special needs, and other factors made it necessary for schools to change teachers' teaching assignments without prior notice. Such reassignments are not unique to NYC's schools. Only 24 of 44 (54%) teachers who participated in the national SWEPT study's (10) first year were available to participate in its second year.
2. Transfer to another NYC public high school. A number of teachers transferred to another NYC public high school between the time of their acceptance into CUSR and their completion of the program. The majority of these transfers were involuntary. (In NYC school parlance these teachers were "excessed," due to changing school needs, budgetary constraints, and a teachers' union contract that stipulates down-sizing schools must eliminate teachers in inverse order of seniority).
3. Lack of a non-participating teacher in the same school teaching the same Regents science subject. For the last eight years NYC's DOE has been eliminating large high schools in favor of small ones. These small high schools often have only one biology, chemistry or earth science teacher.
4. School-wide waiver from Regents exam administration. A number of NYC high schools have sought and obtained Regents examination waivers. These schools use portfolio and other non-Regents assessments.

Supplementary paragraph S-8. Evaluation instruments and data. CUSR employs a number of instruments and methods to assess its impact on teachers and their students (10, ref S-6). 1. A "Spring Implementation Survey" (Table S-7), e-mailed in the spring of each year to all teachers entering and participating in the program, and to teachers who completed it the previous summer. The survey inquires about the teacher's ongoing professional education and classroom practices (Table 1), and about his/her students' participation in science fairs, competitions, and after-school science clubs. Virtually all entering and participating teachers and ~80% of the previous year's CUSR graduates respond to it. 2. NYC DOE's Division of Assessment and Accountability provides anonymized aggregate NY State Regents science exam data (e.g., number of students enrolled and passing (grade $\geq 65\%$) Regents-level Biology/Living Environment, Earth Science, Chemistry, or Physics courses taught by a current or past program participant or non-participating teacher(s)). 3. Faculty mentors and teachers are surveyed at the end of each summer to assess the success of their partnership (ref S-6). A Columbia Teachers College doctoral student studied the classroom practices of one cohort of participating teachers (11). 5. Essential background information about comparability of science teachers and of students in classes of participating and non-participating science teachers within a school were

obtained in the NSF-supported Multi-site SWEPT study (10), of which JD, JM, and SCS were Administrator, Consultant, and Principal Investigator, respectively.

Supplementary paragraph S-9. Human Subjects. Data collection and analysis performed in conjunction with the NSF-supported Multi-site Science Work Experience Programs for Teachers (SWEPT) study cited here were reviewed and approved by the Proposal Review Committee of the Division of Assessment and Accountability of the then NYC Board of Education on 6/17/99 and 4/27/00, and by Columbia University Medical Center's Institutional Review Board (protocol #8391, 01/10/01).

Table S-1: Program Costs	
Teacher stipend @ \$6,000/teacher/summer x 2 summers	\$12
Program enrichment support @ \$1,000/teacher/summer x 2 summers.	\$2
Host laboratory expenses @\$1,000/summer x 2 summers	\$2
Graduate student stipend @ \$200/student/month x 8 months/year x 2 years	\$3
Professional development day and other administrative expenses @ \$500/teacher/summer x 2 summers	\$1
Program administrator/Master teacher – full time @ \$3,900/teacher/year x 2 years	\$7
Total costs @ \$14,000/teacher in first summer + \$14,000/teacher discounted @3.5% for second summer.	\$27
Total costs @ \$28,000/teacher/2 summers x 10 teachers¹	\$273
¹ Second summer's \$14,000 costs discounted @3.5%.	

Table S-2. Demographic Characteristics of CUSRP Program Applicants and Participants		
	160 Applicants 2003-2005	145 CUSRP Graduates 1994-2005
School type		
Public	94%	87%
Independent	5%	9%
Parochial	1%	4%
Race		
African-American	23%	21%
Hispanic	10%	7%
White	50%	55%
Other	17%	17%

Table S-3. - Teaching Experience of CUSRP Participants.

	All teachers completing CUSRP 1994 – 2005¹	95 NYC Public High School teachers eligible for the Student Outcomes Study 1994 – 2005¹			32 NY City Public High School teachers whose students' Regents science exam scores comprise the Student Outcomes Study¹		
No. of science teachers	145 ²	55 females (58%)	40 males (42%)	95	16 females (50%)	16 males (50%)	32 teachers (100%)
Age (avg.)	35.7 yrs	32.9 yrs	38.9 yrs	35.4 yrs	32.9 yrs	39.9 yrs	36.4 yrs
Years teaching experience	8.2 yrs	5.9 yrs	10.2 yrs	7.8 yrs	6.1 yrs	11.4 yrs	8.7 yrs
Years high school science teaching experience	7.9 yrs	5.5 yrs	10 yrs	7.4 yrs	6 yrs	11.3 yrs	8.6 yrs
¹ See text for teacher selection criteria. ² 84 female and 61 male teachers.							

Table S-4. Undergraduate and Graduate Education of CUSRP Participants.

	All teachers completing Program 1994 - 2005	95 NYC Public High School teachers eligible for the Student Outcomes Study 1994 - 2005 ¹			32 NY City Public High School teachers whose students' Regents science exam scores comprise the Student Outcomes Study ¹		
	145 ²	55 females	40 males	95 teachers	16 females	16 males	32 teachers
B.A./B.S. in science	128 = 88.3% ³	49 = 89.1% ⁴	37 = 92.5% ⁵	86 = 90.5% ⁶	14 = 87.5% ⁷	14 = 87.5% ⁸	28 = 87.5% ⁹
B.A. not in science	17 = 11.7% ³	6 = 10.9% ⁴	3 = 7.5% ⁵	9 = 9.5% ⁶	2 = 12.5% ⁷	2 = 12.5% ⁸	4 = 12.5% ⁹
Masters Degree	113 = 77.9% ³	40 = 69% ⁴	35 = 81.4% ⁵	75 = 74.3% ⁶	10 = 62.5% ⁷	14 = 87.5% ⁸	24 = 75% ⁹
Masters degree in a science	36 = 31.8% ¹⁰	11 = 27.5% ¹¹	14 = 32.6% ¹²	25 = 33.3% ¹³	5 = 31.2% ¹⁴	4 = 28.6% ¹⁵	9 = 37.5% ¹⁶
Masters degree in science education	39 = 34.5% ¹⁰	17 = 44.5% ¹¹	14 = 32.6% ¹²	31 = 41.3% ¹³	1 = 6.3% ¹⁴	6 = 42.9% ¹⁵	7 = 29.2% ¹⁶
M.D., D.V.M., J.D., Ph.D., or B.N.S.	11 = 8.7% ³	2 = 3.4% ⁴	5 = 11.6% ⁵	7 = 6.9% ⁶	1 = 3.1% ⁷	0	1 = 3.1% ⁹

¹ See text for teacher selection criteria.

² 84 female and 61 male teachers.

³ Percent of 145 teachers.

⁴ Percent of 55 female teachers.

⁵ Percent of 40 male teachers.

⁶ Percent of 95 teachers.

⁷ Percent of 16 female teachers.

⁸ Percent of 16 male teachers.

⁹ Percent of the 32 teachers whose students Regents exam scores comprise the substantive study's data set.

¹⁰ Percent of 113 teachers with Masters degrees.

¹¹ Percent of 40 female teachers with Masters degrees.

¹² Percent of 35 male teachers with Masters degrees.

¹³ Percent of 75 teachers with Masters degrees.

¹⁴ Percent of 10 female teachers with Masters degrees.

¹⁵ Percent of 14 male teachers with Masters degrees.

¹⁶ Percent of 24 teachers with Masters degrees.

Table S-5. Regents science subjects taught ¹							
	All teachers completing Program 1994 – 2005	95 NYC Public High School teachers eligible for the Student Outcomes Study 1994 – 2005 ¹			32 NY City Public High School teachers whose students' Regents science exam scores comprise the Student Outcomes Study ¹		
Subject taught	145 ²	55 females	40 males	95 teachers	16 females	16 males	32 teachers
Biology (Living Environment)	82 = 57.3% ²	39 = 67.2% ³	22 = 51.2% ⁴	61 = 60.4% ⁵	11 = 68.7% ⁶	9 = 56.2% ⁷	20 = 62.5% ⁸
Chemistry	60 = 41.9% ²	28 = 48.3% ³	19 = 44.2% ⁴	47 = 46.5% ⁵	7 = 31.25% ⁶	7 = 43.7% ⁷	12 = 37.5% ⁸
Earth/Environmental Science	31 = 26.7% ²	12 = 20.7% ³	12 = 27.9% ⁴	24 = 23.8% ⁵	4 = 25% ⁶	2 = 12.5% ⁷	6 = 18.75% ⁸
Physics	24 = 17.5% ²	5 = 8.6% ³	6 = 14% ⁴	11 = 10.9% ⁵	0	0	0

¹ Total = >100% because a number of teachers taught >1 Regents subject.
² Percent of 145 teachers.
³ Percent of 55 female teachers.
⁴ Percent of 40 male teachers.
⁵ Percent of 95 teachers.
⁶ Percent of 16 female teachers.
⁷ Percent of 16 male teachers.
⁸ Percent of 32 teachers whose students Regents exam scores comprise the substantive study's data set.

Table S-6. Status as of years 2 - 4 after CUSRP entry, and as of June 2005 of the 32 teachers who completed CUSRP in the period 1994-2005 and whose students' Regents science exam pass rates comprise the substantive study's principal data set.

Year after CUSRP entry	Classroom teacher in NYC public high schools		Ed. Administration in NYC schools ¹	Other ²	Total	% attrition from classroom teaching per year ³
	Students Regents exam data		Students' Regents exam data NOT reported			
	Reported	NOT reported				
2	31			1	32	1%
3	19	10	2	1	32	2.3%
4	17	12	2	1	32	1.8%
2005	20		6	6	32	1.9%

¹ 2 promoted to Asst. Principal in 3rd year after CUSRP entry, 3 promoted to 2 promoted to Assistant Principal and 1 to Principal in 5th or later years after CUSRP entry.

² 1 Maternity leave in 3rd year after CUSRP entry. 2 Retired in 5th or later years after CUSRP entry. 3 relocated to schools outside NYC in 5th or later years after CUSRP entry.

³ Excluding maternity leave and retirements. Year 3 = 29/32 = 91% = 9%/4 years (year prior to entry + 3 years) = 2.3%. Year 4 = 29/32 = 91% = 9%/5years = 1.8%. May 2009 = 20/26 = 77% = 23%/12 years (1994-2004) = 1.9%.

Supplementary Table S-7.

CLASSROOM TRANSFER IMPLEMENTATION REPORT & SURVEY - SPRING 2005

NAME: _____ SCHOOL: _____

We would like to assess the Columbia program's impact on your classroom instruction during the 2004-05 school year. **Please return this survey in the enclosed envelope no later than May 31, 2005.**

CLASSROOM/LABORATORY ACTIVITIES

Grade(s) you currently teach: _____

Subject(s) you currently teach: _____

Please comment ***only*** on activities ***prompted and/or supported by your Columbia experiences.*** (Note: Space is provided in the questionnaire for paragraph length answers.)

1. Have you developed new or revised content to lessons or labs? (If yes, please describe briefly) _____
2. Have you included examples and/or applications from your research laboratory experience? _____
3. What skills did you acquire from your research laboratory experience? _____
If new skills were acquired, please describe *briefly* which skills you were able to utilize in your classroom _____
4. Do your students participate in long-term research projects? _____
If yes, is this a new component to your classroom instruction? _____
5. Have you included lessons on science careers and related job requirements? _____
6. Did you invite your mentor/grad student/post doc to your school? _____
Did he/she visit your school? _____ If yes, how many times? _____
If yes, did he/she engage the students in hands-on activities? _____
(If yes, please describe briefly)
7. Did you tell your students about your research lab experience? _____
8. Did your students visit a research lab? _____
If yes, What was the total # of students brought to a research lab? _____
9. Briefly describe how you've used your enhancement funds to supplement your Action Plan? If funds were not used, why?
10. Did you receive materials, supplies or equipment from a research lab? _____
If yes, please provide a brief description of what you acquired and how they are used in your school.
11. Did you discuss your Program experiences with other school personnel? _____
12. Did you share Columbia derived information, materials and/or resources with other teachers in your school? _____
13. Did you assume new leadership roles/responsibilities in your school/district/region? _____
14. Did you use contacts and experiences from Columbia to obtain new resources for your classroom? _____
15. Which skills and/or ideas obtained at Columbia did you find useful for teaching?
16. What major obstacles did you encounter in transferring your Columbia experience to the classroom?
17. Please describe any other activities resulting from your Columbia experience that you feel may be important to share.

18. Did you increase hands-on science activities (e.g., doing lab activities; using manipulatives) in your classroom/laboratory? YES ____ NO ____ Did you increase problem-solving activities in your classroom/laboratory? YES ____ NO ____
Are you now reading scientific journals? YES ____ NO ____
Has your teaching-related usage of the Internet increased? YES ____ NO ____
19. Did you receive videotape/DVD copies of the summer science lecture series? ____
If yes, did you share them with your colleagues? ____
Did you show them to your students? ____
20. Did you make use of your Columbia library card? ____
21. Have you had contact with other program teachers during the school year (*check all that apply*) ____ in person; ____ telephone; ____ e-mail
22. # of **in-service training workshops** facilitated by you during the 2004-05 school year:
For the school ____
For your district/region ____
At Citywide workshops ____
23. *High School Teachers Only*: How many students do you have on register? ____ How many of these students will be taking a Regents Examination? ____

For Question #24, **please consult your Department Chair** to collect correct data for your science department (*if applicable* to your school/classes). **When collecting data for the science department, EXCLUDE your students.**

24. # of **2004-05** Intel Science Talent Search Applicants from **your science classes**

of **2004-05** Intel Science Talent Search Applicants from the **science Department**

(**EXCLUDING** your students)
of students from **your classes** participating in **science clubs/extracurricular activities**

of students from your **school** participating in **science clubs/extracurricular activities**

(**EXCLUDING** your students)
25. Do you have recommendations for improving the Monday seminar series?

INSTRUCTIONAL STRATEGIES

Please check the appropriate box to indicate your use of the following strategies as a result of your participation in the *Summer Research Program*.

<u>Strategy</u>	<u>Less</u>	<u>Same</u>	<u>More</u>
Consider a real-world problem relevant to the course and develop a plan to address it.			
Assigned a joint or group project.			
Required oral, formal written reports and/or presentations.			
Integrated math, science and technology			
Computer use			
Introduced new technologies			
Assigned projects on current issues or new developments in science.			

IN YOUR OPINION

- A. What was the **PRIMARY** professional or personal benefit of participating in Columbia's *Summer Research Program*? _____
- B. As a professional development program for teachers, how would you rate Columbia's *Summer Research Program*?
Excellent ____ Very Good ____ Good ____ Fair ____ Poor ____
- C. Recommendation(s)? _____

Table S-8. - Student assessments of classroom practices of SWEPT and Comparison teachers.¹		
	SWEPT Teachers' Students¹	Comparison Teachers' Students¹
Reflected on course material by writing in a notebook.³	2.55²	2.39²
Used primary sources such as journals.³	1.93²	1.8²
Explored career opportunities in math or technology.³	1.86²	1.69²
Teacher has encouraged me to think about math/science careers.⁴	2.84²	2.64²
¹ Mean scores from Post-course Student Survey for 2,187 students of SWEPT teachers and 1,469 students of Comparison teachers in the same schools (ref 8). ² Differences between Study and Comparison teachers' students is significant at $p < 0.05$ using Students T-test. ³ Measured on a 5 point scale where 1 = never, 2 = 1-2 times a month, 3 = 1-2 times a week, 4 = almost every class, 5 = every class in response to the question, "Approximately how often did you engage in the following learning activities in the mathematics/science class that you are currently taking?" ⁴ Measured on a 5 point scale from strongly disagree (1) to strongly agree (5).		

Table S-9. Percent of Teachers Leaving Education 1993-2005^{1,2}				
<u>Characteristic of teachers</u>	<u>Years surveyed</u>			<u>Average</u>
	<u>1993-1995</u>	<u>1999-2000</u>	<u>2003-2005</u>	
4-19 years teaching experience	5.75%	6.5%	6.75%	6.33%
Science teacher	N.A.	7.3%	5.9%	6.6%
Secondary school	6.7%	8.6%	8.6%	7.96%
Central city	N.A.	7.1%	9.9%	8.5%
All teachers	6.6%	7.4%	8.4%	7.4%
¹ Supplementary References, S-1.				
² Supplementary References, S-2.				

Table S-10. Percent and number of additional students passing (grade $\geq 65\%$) a Regents science examination per CUSRP vs. non-CUSRP teacher - 1994-2005.

Row No.		Year prior to teacher entry	Years 1 and 2 after teacher entry	Years 3 and 4 after teacher entry	Total or average %, years 1-4
1	Avg. No. of CUSRP teachers	32	31.5	18	
2	No. CUSRP teachers' students taking Regents science exams ¹	2,111	3,379	1,719	5,098
3	No. CUSRP teachers' students passing Regents science exams ¹	982	1,932	1,062	2,994
4	% CUSRP teachers' students passing Regents science exams	46.5%	57.2%	61.8%	58.7%
5	Estimated No. non-participating teachers' students taking Regents science exams ¹	9,863	17,870	8,368	26,238
6	Estimated No. non-participating teachers' students passing Regents science exams ¹	5,071	9,120	4,257	13,377
7	% non-participating teachers' students passing Regents science exams	51.4%	51%	50.1%	51%
8	Avg. % additional students of each CUSRP teacher vs. students of a non-participating teacher passing ($\geq 65\%$) a Regents science exam ²	- 0.2% ²	5.4% ²	10.1% ²	
9	No. additional students passing a Regents science exam/CUSRP teacher	Not applicable	5.79 ³	9.74 ⁴	15.53

¹ Data for students taking and passing ($\geq 65\%$) biology/Living Environment, chemistry, and earth science Regents exams from NYCDOE's Division of Assessment and Accountability.

² From Fig. 1.

³ 3,379 students x 0.054/31.5 teachers.

⁴ 1,719 students x 0.102/18 teachers.

Table S-11. Estimate of immediate school costs saved, of long-term revenues generated, and of societal costs saved per cohort of 10 CUSRP graduates.

Row No.		
1	Total no. additional students passing a Regents science exam in years 1-4 after teacher entry into CUSRP/cohort of 10 teachers (Table S-9, Row 4).	155.3¹
Immediate Economic Benefits = Course Repetition and Teacher Recruitment costs saved by NYC's DOE.		
2	Course Repetition costs saved/10 CUSRP teachers @ \$2,107/student/course² x 155.3 students/10 CUSRP teachers, discounted at 3.5%.^{2,3}	\$297,845
3	Teacher Recruitment costs saved for 1.4 teachers @\$15,306/teacher⁴ (discounted @3.5%/year x 3 years)	\$18,980
4	Total Course Repetition and Teacher Recruitment costs saved (sum of rows 2 + 3 above (discounted @3.5%/year).	\$316,825
5	Four year return (Row 4) per \$1 program costs.⁵	\$1.15
Long-term Economic Benefits assuming 10% of the additional 159.1 students who pass a Regents science exam also graduate from high school with a NY State Regents diploma.		
6	No. additional high school graduates/10 CUSRP teachers/4 years.	15.53
7	Present value (discounted at 3.5%) of lifetime public economic benefits (additional taxes paid, and health, welfare, and crime benefits saved) per 15.53 additional high school graduates.⁷	\$2,828,418
8	Long-term economic return per \$1 program costs.⁸	\$10.27

¹ Data from Supplementary Table S-9, Row 4 x 10 teachers.

² @ \$10,538 total general education instructional cost/student/year (Supporting materials ref S-4), divided by 5 courses/student/year = \$2,107.

³ Discounted @ 3.5% for the present value as follows: (2.895 additional students/teacher passing in 1st year after teacher entry into CUSRP [Table S-9] x 0.966 [discount factor]) + (2.895 additional students/teacher passing in 2nd year [Table S-9]) x 0.933 (discount factor) + (4.87 additional students/teacher passing in 3rd year [Table S-9]) x 0.901 (discount factor) + (4.87 additional students/teacher passing in 4th year [Table S-9]) x 0.871 (discount factor) x \$2,107/student/course x 10 teachers.

⁴ Difference in attrition of CUSRP vs. non-CUSRP teachers. CUSRP teachers @ 1%/yr in 2nd academic yr after program entry, and at 2%/yr in 3rd and 4th academic yrs after program entry = 9.5 CUSRP teachers remaining in education – 8.2 non-CUSRP teachers remaining in education = 1.4 teachers x \$15,306 recruitment cost/teacher (Supporting materials, ref S-2) discounted @ 3.5% x 3 years.

⁵ Row 4/\$27,526/teacher for the two summer program x 10 teachers (Supplementary Table S-1).

⁶ 15.53 additional high school graduates/teacher x \$209,100 (discounted @3.5%)/additional high school graduate for additional taxes paid per 45 year working life and health, welfare, criminal justice costs saved (23) further discounted @3.5% for 4 yrs of high school.

⁸ Row 7/\$275,260 (Table S-1).

Table S-12. NYC public high school students' performance on New York State Regents exams (2005-06)¹		
Subject	No. students tested	% scoring $\geq 65\%$
Physics	10,567	72.9%
U.S. History and Government	65,271	64.0
English	70,344	62.9
Math A	76,930	62.3
Earth Science	39,688	58.8
Chemistry	24,062	58.0
Biology (Living Environment)	65,322	56.5
Average for Earth Science, Chemistry & Biology	129,072	57.4
Global History and Geography	77,999	49.4
¹ Supplementary references, S-3.		

Table S-13		Course repetition costs saved by NYC's DOE for the 2,099 additional students who passed a biology/Living Environment, chemistry, or earth science Regents exam - 1994 - 2005.										
Year teacher entered CUSRP	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
No. teachers ¹	7.9	7.9	7.8	7.7	7.5	7.0	6.6	6.2	5.8	5.4	5.1	4.8
No additional students passing ²	23.6	23.6	38.0	37.5	35.1	32.9	30.8	28.9	27.1	25.4	23.8	22.3
Course repetition costs saved ³	\$49,686	\$49,686	\$80,037	\$79,010	\$74,033	\$69,369	\$64,998	\$60,904	\$57,067	\$53,471	\$50,103	\$46,946
No. teachers ¹		7.9	7.9	7.8	7.7	7.5	7.0	6.6	6.2	5.8	5.4	5.1
No additional students passing ²		23.6	23.6	38.0	37.5	35.1	32.9	30.8	28.9	27.1	25.4	23.8
Course repetition costs saved ³		\$49,686	\$49,686	\$80,037	\$79,010	\$74,033	\$69,369	\$64,998	\$60,904	\$57,067	\$53,471	\$50,103
No. teachers ¹			7.9	7.8	7.8	7.7	7.5	7.0	6.6	6.2	5.8	5.4
No additional students passing ²			23.6	23.6	38.0	37.5	35.1	32.9	30.8	28.9	27.1	25.4
Course repetition costs saved ³			\$49,686	\$49,686	\$80,037	\$79,010	\$74,033	\$69,369	\$64,998	\$60,904	\$57,067	\$53,471
No. teachers ¹				7.9	7.9	7.8	7.7	7.5	7.0	6.6	6.2	5.8
No additional students passing ²				23.6	23.6	38.0	37.5	35.1	32.9	30.8	28.9	27.1
Course repetition costs saved ³				\$49,686	\$49,686	\$80,037	\$79,010	\$74,033	\$69,369	\$64,998	\$60,904	\$57,067
No. teachers ¹					7.9	7.9	7.8	7.7	7.5	7.0	6.6	6.2
No additional students passing ²					23.6	23.6	38.0	37.5	35.1	32.9	30.8	28.9
Course repetition costs saved ³					\$49,686	\$49,686	\$80,037	\$79,010	\$74,033	\$69,369	\$64,998	\$60,904
No. teachers ¹						7.9	7.9	7.8	7.7	7.5	7.0	6.6
No additional students passing ²						23.6	23.6	38.0	37.5	35.1	32.9	30.8
Course repetition costs saved ³						\$49,686	\$49,686	\$80,037	\$79,010	\$74,033	\$69,369	\$64,998
No. teachers ¹							7.9	7.9	7.8	7.7	7.5	7.0
No additional students passing ²							23.6	23.6	38.0	37.5	35.1	32.9
Course repetition costs saved ³							\$49,686	\$49,686	\$80,037	\$79,010	\$74,033	\$69,369
No. teachers ¹								7.9	7.9	7.8	7.7	7.5
No additional students passing ²								23.6	23.6	38.0	37.5	35.1
Course repetition costs saved ³								\$49,686	\$49,686	\$80,037	\$79,010	\$74,033
No. teachers ¹									7.9	7.9	7.8	7.7
No additional students passing ²									23.6	23.6	38.0	37.5
Course repetition costs saved ³									\$49,686	\$49,686	\$80,037	\$79,010
No. teachers ¹										7.9	7.9	6.9
No additional students passing ²										23.6	23.6	38.0
Course repetition costs saved ³										\$49,686	\$49,686	\$71,090
No. teachers ¹											7.9	7.9
No additional students passing ²											23.6	23.6
Course repetition costs saved ³											\$49,686	\$49,686
No. teachers ¹												7.9
No additional students passing ²												23.6
Course repetition costs saved ³												\$49,686
Total no. of CUSRP teachers' students taking a Regents science exam.										2,355		
Total course repetition costs saved .										\$4,961,985		
¹ CUSRP teacher attrition @1%/year in academic year 2 following teacher entry into CUSRP, 2%/year in academic years 3 and 4 following teacher entry into CUSRP (Table S-6), and 6.3%/year every year thereafter (Table S-8) = 79.7 teachers. Attrition non-CUSRP teachers = 6.3%/year in year 2 and every year thereafter (Table S-8) = 69.7 teachers. Difference in attrition CUSRP teachers - non-CUSRP teachers = 10 teachers x \$15,306/teacher (Table S-10, row 3) = \$153,060.												
² No. additional students passing = No. students passing a Regents biology/Living Environment, chemistry, or earth science exam per CUSRP teacher x No. of teachers remaining in classroom teaching as reported in row immediately above.												
³ Course repetition costs saved = No. additional students passing x \$2,107/student (Table S-10, row 2)												
⁴ Total student course repetition costs (\$4,939,482) + teacher replacement costs (\$153,060) saved = \$5,115,045.												

Supplementary references.

- S-1. http://eric.ed.gov/ERICDocs/data/ericdocs2sql/content_storage_01/0000019b/80/29/e3/4a.pdf, downloaded 2/5/09
- S-2. Teacher Attrition: A Costly Loss to the Nation and to the States. Issue Brief 2005. Alliance for Excellent Education.
<http://www.all4ed.org/files/archive/publications/TeacherAttrition.pdf>, downloaded 3/15/09
- S-3 http://schools.nyc.gov/OA/SchoolReports/2005-06/ASR_M296.pdf, downloaded 5-28-09
- S-4. http://www.nycenet.edu/offices/d_chanc_oper/budget/exp01/y2005_2006/function.asp?R=2, downloaded 1/ 31/09