

# **STUDENT ACHIEVEMENT MEASURES WE HAVE USED OR ARE IN THE PROCESS OF USING**

## **Classroom Focused**

- Passing Rate Data (all four quarters) (Philadelphia)
- Grade Point Averages (Central HS, pending Palisades SD)
- Attendance Rates (Philadelphia)
- Attitudinal surveys of students (Philadelphia + Furness HS)

## **Criterion Referenced, School Achievement Focused**

- Stanford Achievement Test--9<sup>th</sup> Edition (SAT-9) Philadelphia
- New Standards Reference Exam (pending, Bethlehem, Palisades SD)
- New York Regent's Math Exam (pending Sequential and the "Form A") Core-Plus Algebra Test (pending, Strath Haven Research Study)
- NAEP statistics questions (pending, Strath Haven Research Study)
- GEPA, HEPA (pending New Jersey "Education Proficiency Assessments", Pennsauken, Haddon Twp, N. Burlington SDs)

## **Norm-Referenced, School Comparison Focused**

- Pennsylvania System for Student Assessment (PSSA) (pending)
- Education Record Bureau (ERBs) + SATs (pending Strath Haven HS)

## **College Admission Focused**

- Scholastic Aptitude Test scores (PSATs and SATs)
- Ivy League University Math Exit Test

Philadelphia Community College Admissions Test (pending)

SCHOOL DISTRICT OF PHILADELPHIA  
NINTH GRADE STUDENT ATTITUDES OF  
THE INTERACTIVE MATHEMATICS PROGRAM

Summary Report by:

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Significant contributions to the  
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High School and Ella Travis, Principal  
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February, 1995

## Executive Summary

In May/June, 1994 an attitudinal survey was given to the Interactive Mathematics Program (IMP) students after one year of participation. One hundred and seventy one (171) **ninth grade** IMP students from four different schools responded. This represented 71% of IMP students in these schools.

The schools and respective number of students were as follows:

1) Carver High School for Engineering and Science	70
2) Dobbins Academic Vocational Schools	20
3) Philadelphia High School for Girls	52
4) Strawberry Mansion High School	29

Schools not surveyed were Central and Gratz High Schools. The attached tables are quantitative analyses of this survey data.

Positive findings:

This survey indicated that IMP students had very positive attitudes of the program. 71.3% of the students would opt to take the IMP curriculum again if offered the choice.

There were some interesting differences in the students' responses from different schools. Strawberry Mansion, a racially isolated comprehensive high school, seemed to have the most positive attitude towards the program, with 96.5% of them opting to take IMP again. They had few negative comments.

The responses from Dobbins were also very positive, with Carver and Girls' High slightly less positive. Although there were differences, the general trend was very similar and the responses scoring the highest were the same for all the schools, albeit to different degrees.

One of the most promising results from the survey were the responses to questions 8 and 9, regarding retention of concepts. The students seem to retain more mathematical concepts in IMP, than in their 8<sup>th</sup> grade math class.

Group work seemed to be the most popular aspect of the program. Although a few people did not like it, the vast majority (95.4%) did. They found it helped them to better understand math and made them feel as though they were not alone in their learning, especially when experiencing difficulties. At Girls' High there was an especially positive response (73.1% very positive and 25% somewhat positive). Even students who disliked or had difficulties with every other aspect of the program, liked the group work.

The students also liked learning a combination of mathematical topics, rather than only one isolated segment of mathematics, such as algebra or geometry. They felt they were learning a wider range of subjects than their peers in the traditional math class and felt confident and proud of the fact that they were learning concepts that they would ordinarily learn only in the 12<sup>th</sup> grade.

The students said that IMP makes math fun. They enjoyed the hands on activities and experiments and felt that it related to their lives. All these conditions seemed to increase student motivation, which hopefully will have a positive effect on their learning.

Students mentioned that their problem solving skills had improved and this was helping them in other courses and in real life to solve problems and to think things through.

Some of the students found the program easier than traditional algebra, yet others found it more difficult. Many of those who found it more difficult thought it was challenging, which they liked. Others, however, found the difficulty frustrating and felt more comfortable with the certainty and routine of their traditional math class.

One very positive sign is that when asked what they did not like about the program, a relatively large proportion of the students replied "nothing".

#### Negative findings:

Most negative attitudes were directly related to specific parts of the program. Some students expressed negative attitudes to the program as a whole as they did not feel that it was compatible with their learning style.

The most frequent dislike of the program was the homework. The students found it a difficult adjustment to be assessed on their homework and having to do their homework assignments everyday in order to pass. They also found the homework assignments difficult and confusing at times. Perhaps it may take an adjustment period to get used to the homework.

The responses to questions 5 are split more or less evenly between those that believed that the activities and instruction in IMP are helping them in other courses, and those that did not. On the surface, this may not seem that positive, however, the number of students responding affirmatively to the question, is unknown compared to if students in a traditional math program were asked the same questions. Perhaps this can be explored further in future research.

Selected quotes from students' surveys.

"I consider myself a writer, actress, singer, ANYTHING but a mathematician, but IMP makes me feel like I know."

"I am very good at math, but I do not like the formal method of teaching math. It never shows a connection to real life."

"I would choose IMP because I am really bad in math. With IMP my grades have been much better."

"IMP lets you deal with real situations that you would need when growing up."

"I feel what I have learned I will use a lot in life, no matter what my career is."

"I like working in groups instead of just myself, because if I don't understand something, someone of my age can help me."

"It is much harder, but I prefer a better challenge."

"Although this course was tough in the beginning, I'm glad I stuck with it because to my surprise - math is fun."

"Takes time to develop a liking to this program because it is very difficult in the beginning."

"I remember everything in this class that I learned. All that I remember from my 8<sup>th</sup> grade class is  $\pi=3.14$ ."

"It's easier to understand now because we do experiments to prove it instead of just taking the teacher's word for it."

"I feel very proud of being in this program because other kids in other courses don't learn as fast we do."

"It helps me organizing my info, explaining my thoughts into words and gives me different options when solving problems."

Next steps:

This year we intend to do a follow up survey of these students, now in their second year and do a similar survey for the students currently involved in the first year of the program. Also we plan to get some comparative data from non-IMP students on their attitudes towards mathematics.

**PHILADELPHIA NINTH GRADE STUDENT ATTITUDES  
OF THE INTERACTIVE MATHEMATICS PROGRAM  
May/June 1994**

**ALL SCHOOLS**

Number of students in the survey:

**171 out of 242**

1. HAVE YOU TAKEN ALGEBRA IN 8<sup>TH</sup> GRADE?

<b>Yes</b>	<b>64.3%</b>	No	33.9%	Undecided	0.0%	No Response	1.8%
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2. Questions About the Curriculum/Instruction	VERY POSITIVE	SOMEWHAT POSITIVE	NEGATIVE	VERY NEGATIVE	NO RESPONSE
A. How do you feel about the method by which you are being tested in math?	<b>27.5%</b>	<b>62.0%</b>	8.2%	2.3%	0.0%
B. How do you feel about working in groups?	<b>60.8%</b>	<b>34.6%</b>	2.3%	2.3%	0.0%
C. How do you feel about the writing component in your math class?	<b>22.8%</b>	<b>55.5%</b>	17.0%	4.1%	0.6%
D. How do you feel about the oral presentations that you are required to make?	<b>27.5%</b>	<b>49.1%</b>	17.0%	6.4%	0.0%
E. How do you feel about the type of homework assignments given to you in your math class?	<b>21.6%</b>	<b>56.7%</b>	13.5%	8.2%	0.0%

3. IN 12<sup>TH</sup> GRADE THERE IS AN OPTIONAL IMP COURSE. DO YOU PLAN TO TAKE IT?

<b>Yes</b>	<b>72.5%</b>	No	23.9%	Undecided	1.8%	No Response	1.8%
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4. IF YOU HAD TO CHOOSE YOUR MATH COURSE AGAIN, WHICH COURSE WOULD YOU TAKE?

<b>IMP</b>	<b>71.3%</b>	Algebra	26.9%	Undecided	1.2%	No Response	0.6%
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5. DO IMP ACTIVITIES AND METHODS OF INSTRUCTION HELP YOU IN YOUR OTHER COURSES?

<b>Yes</b>	<b>46.8%</b>	No	49.1%	Undecided	1.8%	No Response	2.3%
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(#6, 7 Open-ended questions, see attached)

8. ARE YOU ABLE TO RETAIN THE CONCEPTS THAT ARE TAUGHT IN YOUR IMP CLASS?

<b>Yes</b>	<b>83.6%</b>	No	8.8%	Some	5.3%	No Response	2.3%
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9. WERE YOU ABLE TO RETAIN THE CONCEPTS TAUGHT IN YOUR 8<sup>TH</sup> GRADE MATH CLASS?

<b>Yes</b>	<b>71.9%</b>	No	20.5%	Some	5.3%	No Response	2.3%
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(#10, 11 Open-ended questions, see attached)

**PHILADELPHIA NINTH GRADE STUDENT ATTITUDES  
OF THE INTERACTIVE MATHEMATICS PROGRAM  
May/June 1994**

**SCHOOL: STRAWBERRY**      Number of students in the survey:      **29 out**  
**of 34**  
**MANSION**

1. HAVE YOU TAKEN ALGEBRA IN 8<sup>TH</sup> GRADE?

<b>Yes</b>	<b>13.7%</b>	No	79.3%	Undecided	0.0%	No Response	0.0%
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2. Questions About the Curriculum/Instruction	VERY POSITIVE	SOMEWHAT POSITIVE	NEGATIVE	VERY NEGATIVE	NO RESPONSE
	A. How do you feel about the method by which you are being tested in math?	<b>34.5%</b>	<b>65.5%</b>	0.0%	0.0%
B. How do you feel about working in groups?	<b>62.1%</b>	<b>37.9%</b>	0.0%	0.0%	0.0%
C. How do you feel about the writing component in your math class?	<b>31.0%</b>	<b>65.5%</b>	3.5%	0.0%	0.0%
D. How do you feel about the oral presentations that you are required to make?	<b>41.4%</b>	<b>44.8%</b>	10.3%	3.5%	0.0%
E. How do you feel about the type of homework assignments given to you in your math class?	<b>34.5%</b>	<b>51.7%</b>	6.9%	6.9%	0.0%

3. IN 12<sup>TH</sup> GRADE THERE IS AN OPTIONAL IMP COURSE. DO YOU PLAN TO TAKE IT?

<b>Yes</b>	<b>96.5%</b>	No	0.0%	Undecided	0.0%	No Response	3.5%
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4. IF YOU HAD TO CHOOSE YOUR MATH COURSE AGAIN, WHICH COURSE WOULD YOU TAKE?

<b>IMP</b>	<b>96.5%</b>	Algebra	3.5%	Undecided	0.0%	No Response	0.0%
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5. DO IMP ACTIVITIES AND METHODS OF INSTRUCTION HELP YOU IN YOUR OTHER COURSES?

<b>Yes</b>	<b>62.0%</b>	No	34.5%	Undecided	0.0%	No Response	3.5%
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(#6, 7 Open-ended questions, see attached)

8. ARE YOU ABLE TO RETAIN THE CONCEPTS THAT ARE TAUGHT IN YOUR IMP CLASS?

<b>Yes</b>	<b>89.7%</b>	No	0.0%	Some	0.0%	No Response	10.3%
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9. WERE YOU ABLE TO RETAIN THE CONCEPTS TAUGHT IN YOUR 8<sup>TH</sup> GRADE MATH CLASS?

<b>Yes</b>	<b>72.4%</b>	No	17.2%	Some	0.0%	No Response	10.3%
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(#10, 11 Open-ended questions, see attached)

**PHILADELPHIA NINTH GRADE STUDENT ATTITUDES  
OF THE INTERACTIVE MATHEMATICS PROGRAM  
May/June 1994**

**SCHOOL: DOBBINS  
of 31**

Number of students in the survey:

**20 out**

1. HAVE YOU TAKEN ALGEBRA IN 8<sup>TH</sup> GRADE?

<b>Yes</b>	<b>36.6%</b>	No	61.5%	Undecided	1.9%	No Response	0.0%
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2. Questions About the Curriculum/Instruction	VERY POSITIVE	SOMEWHAT POSITIVE	NEGATIVE	VERY NEGATIVE	NO RESPONSE
A. How do you feel about the method by which you are being tested in math?	<b>35.0%</b>	<b>65.0%</b>	0.0%	0.0%	0.0%
B. How do you feel about working in groups?	<b>55.0%</b>	<b>35.0%</b>	10.0%	0.0%	0.0%
C. How do you feel about the writing component in your math class?	<b>30.0%</b>	<b>60.0%</b>	5.0%	0.0%	5.0%
D. How do you feel about the oral presentations that you are required to make?	<b>30.0%</b>	<b>45.0%</b>	20.0%	5.0%	0.0%
E. How do you feel about the type of homework assignments given to you in your math class?	<b>20.0%</b>	<b>60.0%</b>	15.0%	5.0%	0.0%

3. IN 12<sup>TH</sup> GRADE THERE IS AN OPTIONAL IMP COURSE. DO YOU PLAN TO TAKE IT?

<b>Yes</b>	<b>90.0%</b>	No	5.0%	Undecided	0.0%	No Response	5.0%
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4. IF YOU HAD TO CHOOSE YOUR MATH COURSE AGAIN, WHICH COURSE WOULD YOU TAKE?

<b>IMP</b>	<b>85.0%</b>	Algebra	15.0%	Undecided	0.0%	No Response	0.0%
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5. DO IMP ACTIVITIES AND METHODS OF INSTRUCTION HELP YOU IN YOUR OTHER COURSES?

<b>Yes</b>	<b>45.0%</b>	No	45.0%	Undecided	0.0%	No Response	10.0%
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(#6, 7 Open-ended questions, see attached)

8. ARE YOU ABLE TO RETAIN THE CONCEPTS THAT ARE TAUGHT IN YOUR IMP CLASS?

<b>Yes</b>	<b>95.0%</b>	No	0.0%	Some	5.0%	No Response	0.0%
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9. WERE YOU ABLE TO RETAIN THE CONCEPTS TAUGHT IN YOUR 8<sup>TH</sup> GRADE MATH CLASS?

<b>Yes</b>	<b>80.0%</b>	No	15.0%	Some	5.0%	No Response	0.0%
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(#10, 11 Open-ended questions, see attached)

**PHILADELPHIA NINTH GRADE STUDENT ATTITUDES  
OF THE INTERACTIVE MATHEMATICS PROGRAM  
May/June 1994**

**SCHOOL: CARVER  
of 86**

Number of students in the survey:

**70 out**

1. HAVE YOU TAKEN ALGEBRA IN 8<sup>TH</sup> GRADE?

<b>Yes</b>	<b>85.7%</b>	No	14.3%	Undecided	0.0%	No Response	0.0%
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2. Questions About the Curriculum/Instruction	VERY POSITIVE	SOMEWHAT POSITIVE	NEGATIVE	VERY NEGATIVE	NO RESPONSE
A. How do you feel about the method by which you are being tested in math?	<b>32.9%</b>	<b>50.0%</b>	12.9%	4.2%	0.0%
B. How do you feel about working in groups?	<b>52.9%</b>	<b>40.0%</b>	1.4%	5.7%	0.0%
C. How do you feel about the writing component in your math class?	<b>21.4%</b>	<b>54.3%</b>	18.6%	5.7%	0.0%
D. How do you feel about the oral presentations that you are required to make?	<b>28.6%</b>	<b>47.1%</b>	14.3%	10.0%	0.0%
E. How do you feel about the type of homework assignments given to you in your math class?	<b>27.1%</b>	<b>54.3%</b>	10.0%	8.6%	0.0%

3. IN 12<sup>TH</sup> GRADE THERE IS AN OPTIONAL IMP COURSE. DO YOU PLAN TO TAKE IT?

<b>Yes</b>	<b>62.9%</b>	No	34.3%	Undecided	1.4%	No Response	1.4%
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4. IF YOU HAD TO CHOOSE YOUR MATH COURSE AGAIN, WHICH COURSE WOULD YOU TAKE?

<b>IMP</b>	<b>68.6%</b>	Algebra	27.2%	Undecided	2.8%	No Response	1.4%
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5. DO IMP ACTIVITIES AND METHODS OF INSTRUCTION HELP YOU IN YOUR OTHER COURSES?

<b>Yes</b>	<b>48.6%</b>	No	47.1%	Undecided	2.8%	No Response	1.4%
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(#6, 7 Open-ended questions, see attached)

8. ARE YOU ABLE TO RETAIN THE CONCEPTS THAT ARE TAUGHT IN YOUR IMP CLASS?

<b>Yes</b>	<b>78.6%</b>	No	14.3%	Some	5.7%	No Response	1.4%
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9. WERE YOU ABLE TO RETAIN THE CONCEPTS TAUGHT IN YOUR 8<sup>TH</sup> GRADE MATH CLASS?

<b>Yes</b>	<b>68.6%</b>	No	24.3%	Some	5.7%	No Response	1.4%
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(#10, 11 Open-ended questions, see attached)

**PHILADELPHIA NINTH GRADE STUDENT ATTITUDES  
OF THE INTERACTIVE MATHEMATICS PROGRAM  
May/June 1994**

**SCHOOL: GIRLS' HIGH  
of 91**

Number of students in the survey:

**52 out**

1. HAVE YOU TAKEN ALGEBRA IN 8<sup>TH</sup> GRADE?

<b>Yes</b>	<b>63.5%</b>	No	34.6%	Undecided	0.0%	No Response	1.4%
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2. Questions About the Curriculum/Instruction	VERY POSITIVE	SOMEWHAT POSITIVE	NEGATIVE	VERY NEGATIVE	NO RESPONSE
A. How do you feel about the method by which you are being tested in math?	<b>13.5%</b>	<b>75.0%</b>	9.6%	1.9%	0.0%
B. How do you feel about working in groups?	<b>73.1%</b>	<b>25.0%</b>	1.9%	0.0%	0.0%
C. How do you feel about the writing component in your math class?	<b>17.3%</b>	<b>50.0%</b>	26.9%	5.8%	0.0%
D. How do you feel about the oral presentations that you are required to make?	<b>17.3%</b>	<b>55.8%</b>	23.1%	3.8%	0.0%
E. How do you feel about the type of homework assignments given to you in your math class?	<b>7.7%</b>	<b>61.5%</b>	21.2%	9.6%	0.0%

3. IN 12<sup>TH</sup> GRADE THERE IS AN OPTIONAL IMP COURSE. DO YOU PLAN TO TAKE IT?

<b>Yes</b>	<b>65.4%</b>	No	30.8%	Undecided	3.8%	No Response	0.0%
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4. IF YOU HAD TO CHOOSE YOUR MATH COURSE AGAIN, WHICH COURSE WOULD YOU TAKE?

<b>IMP</b>	<b>55.8%</b>	Algebra	44.2%	Undecided	0.0%	No Response	0.0%
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5. DO IMP ACTIVITIES AND METHODS OF INSTRUCTION HELP YOU IN YOUR OTHER COURSES?

<b>Yes</b>	<b>36.6%</b>	No	61.5%	Undecided	1.9%	No Response	0.0%
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(#6, 7 Open-ended questions, see attached)

8. ARE YOU ABLE TO RETAIN THE CONCEPTS THAT ARE TAUGHT IN YOUR IMP CLASS?

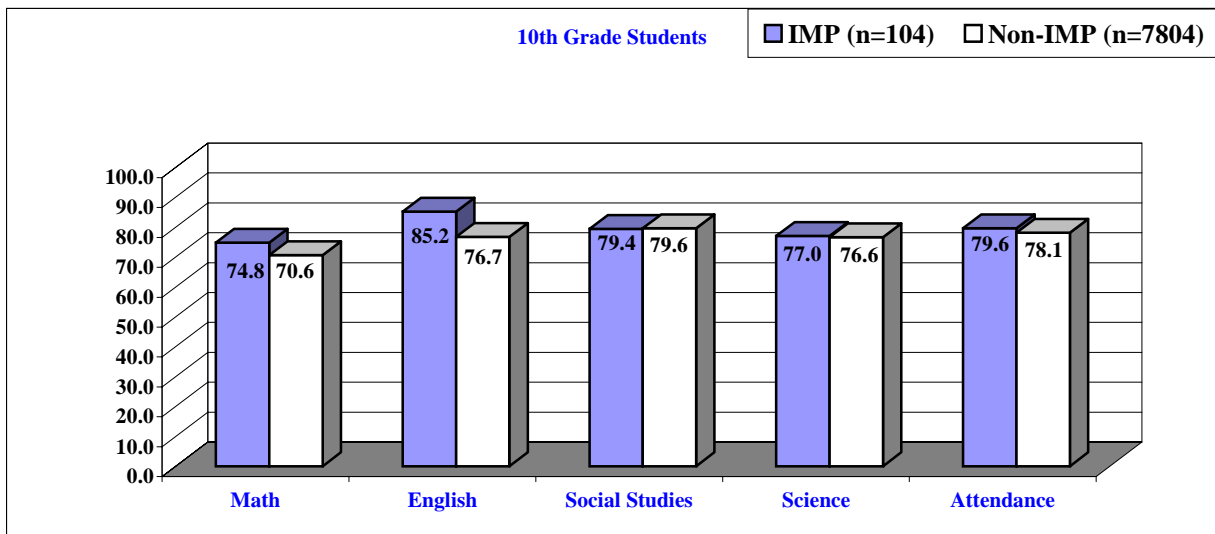
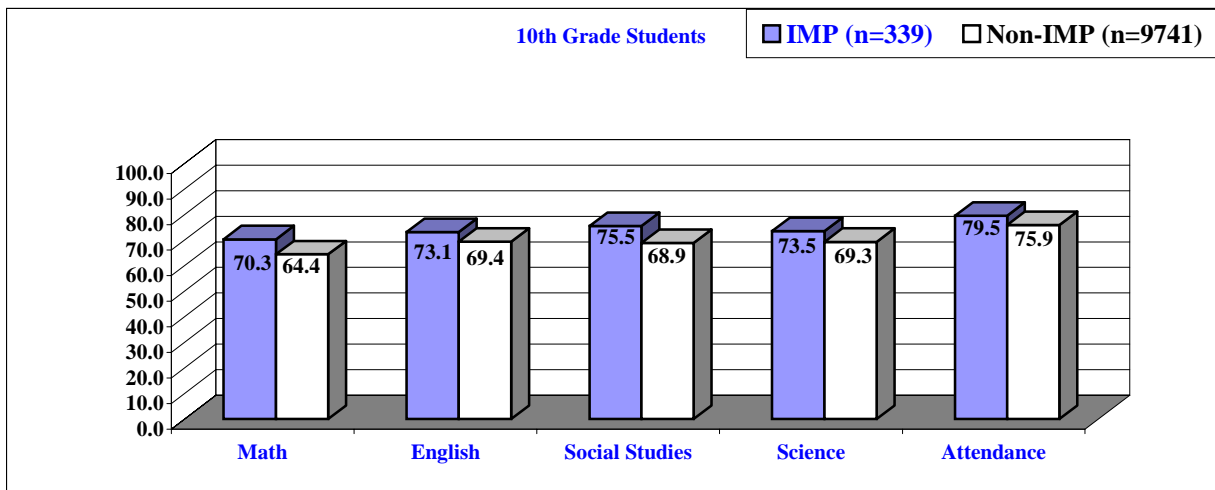
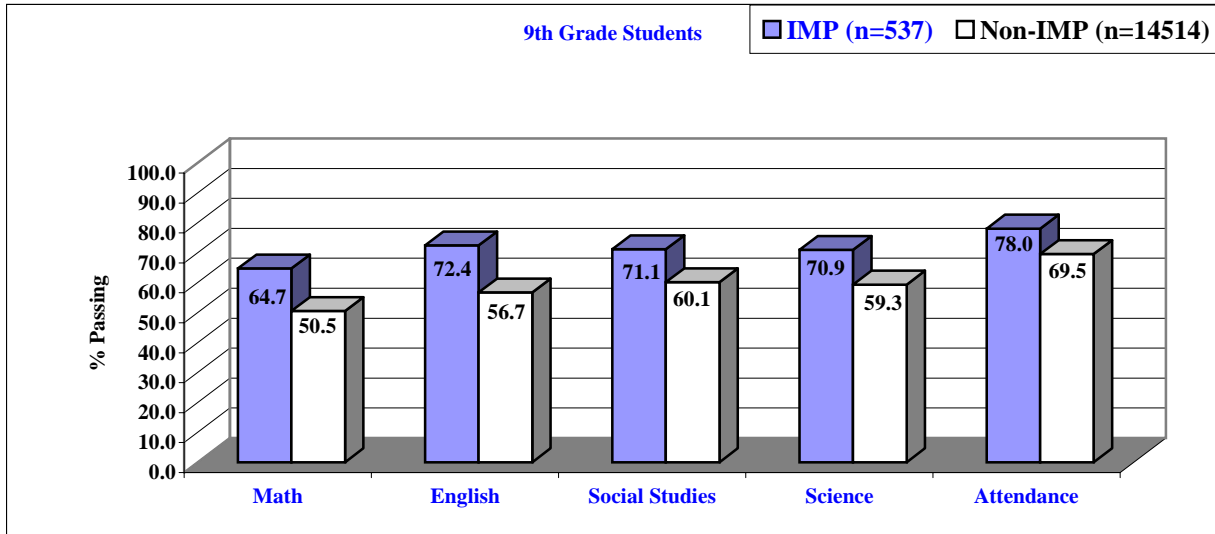
<b>Yes</b>	<b>82.7%</b>	No	9.6%	Some	7.7%	No Response	0.0%
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9. WERE YOU ABLE TO RETAIN THE CONCEPTS TAUGHT IN YOUR 8<sup>TH</sup> GRADE MATH CLASS?

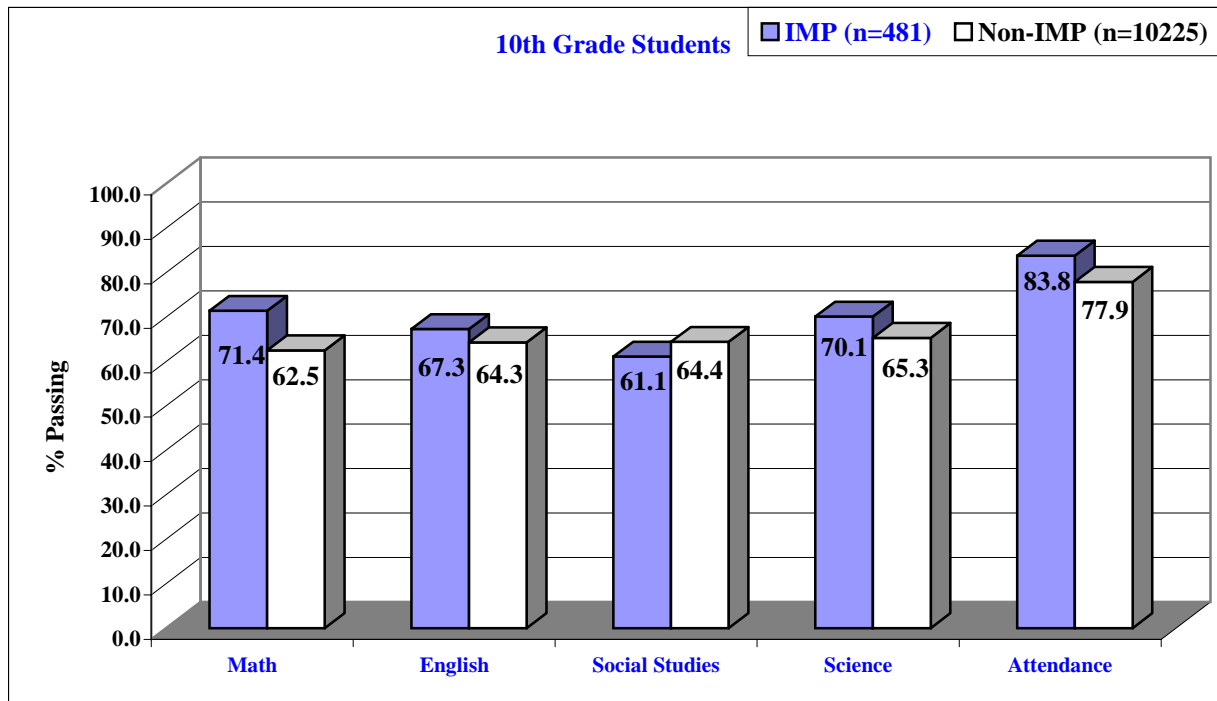
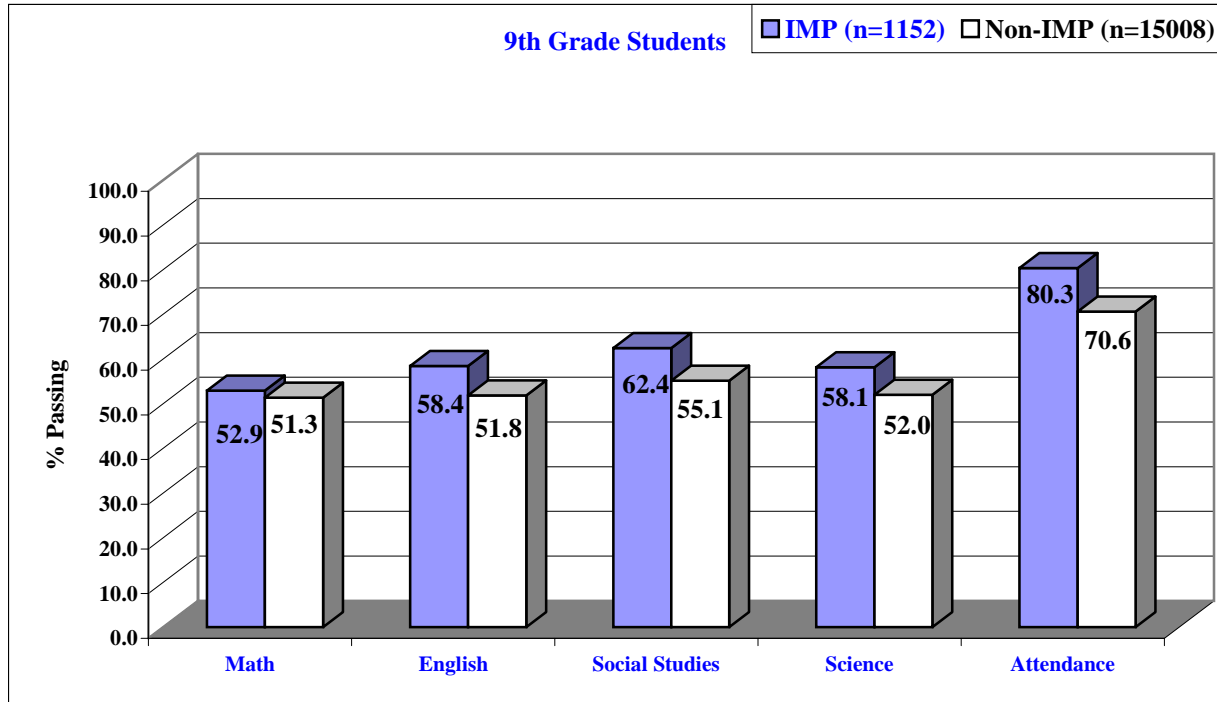
<b>Yes</b>	<b>73.1%</b>	No	19.2%	Some	7.7%	No Response	0.0%
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(#10, 11 Open-ended questions, see attached)

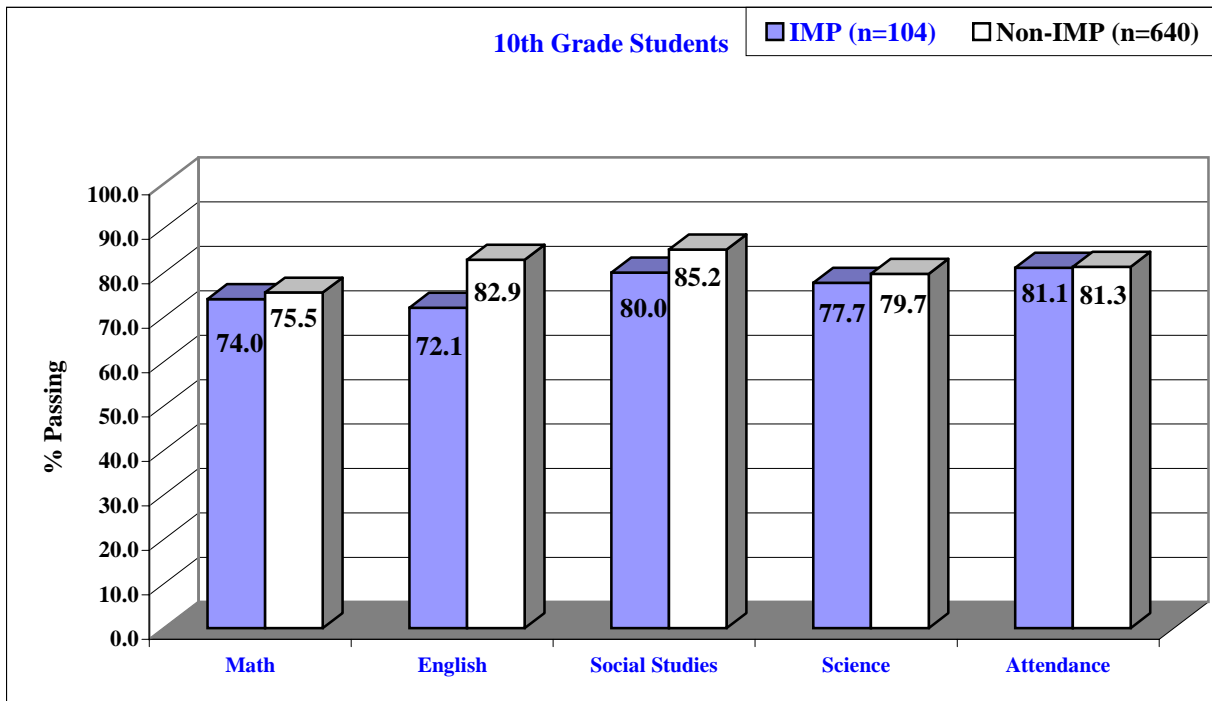
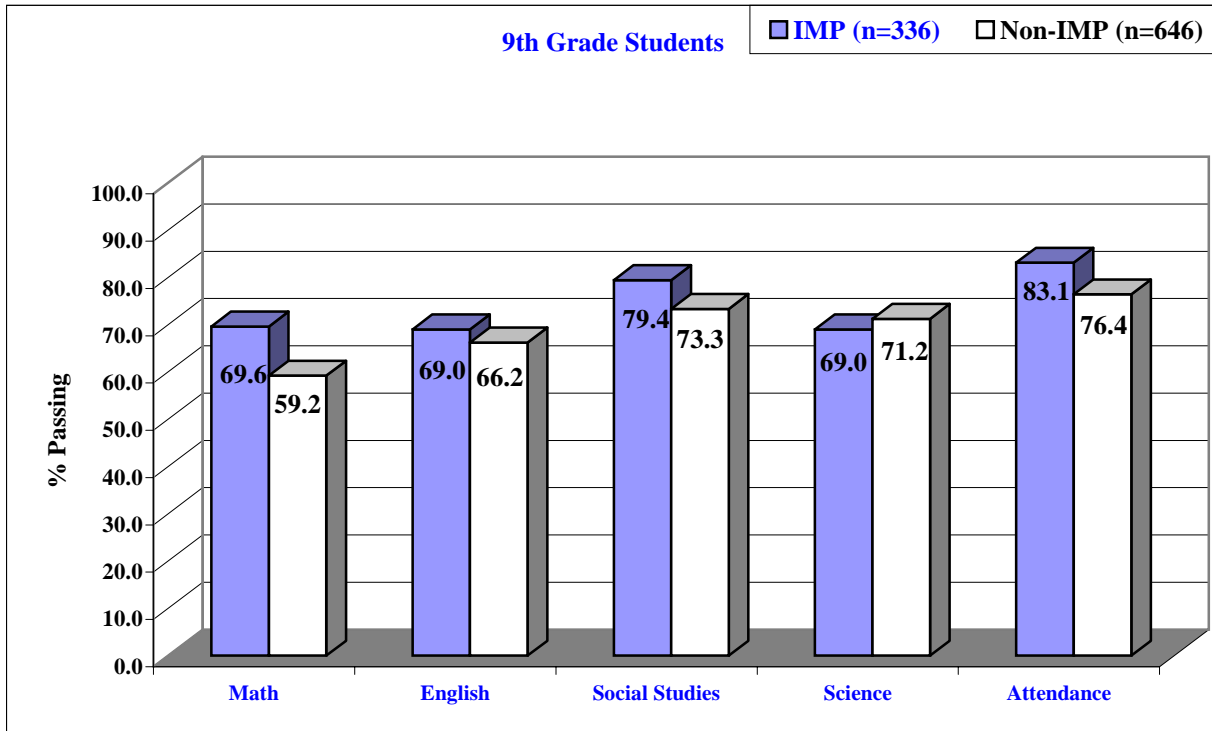
**Summary of IMP vs. Non-IMP Students  
All Comprehensive Schools: IMP and Non-IMP  
Final Report Period -- June 1996**



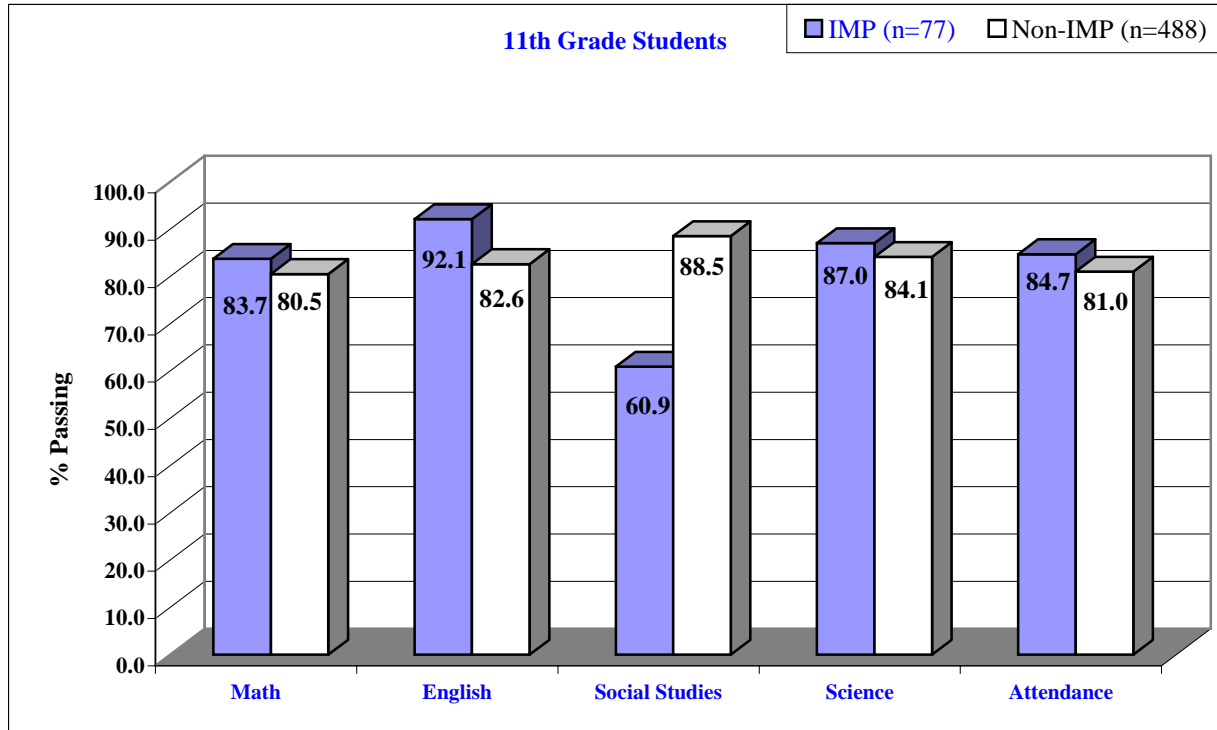
**Summary of IMP vs. Non-IMP Students**  
**All Comprehensive Schools: IMP and Non-IMP**  
**Final Report Period -- June 1997**



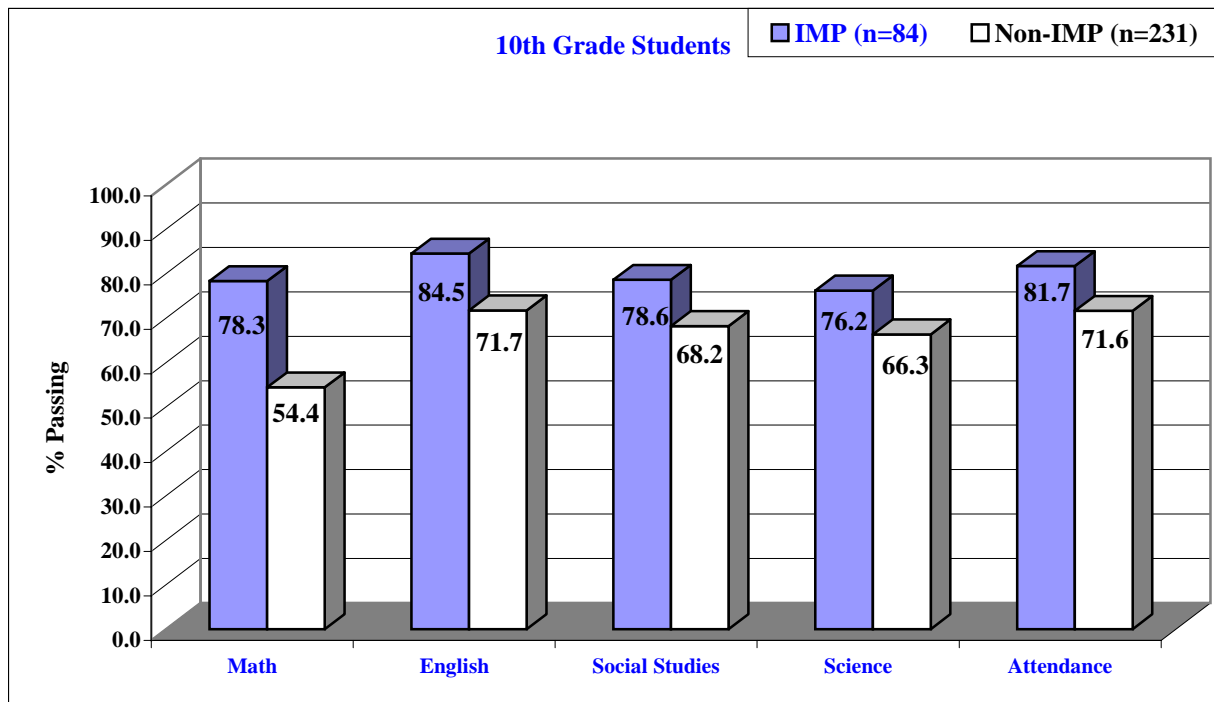
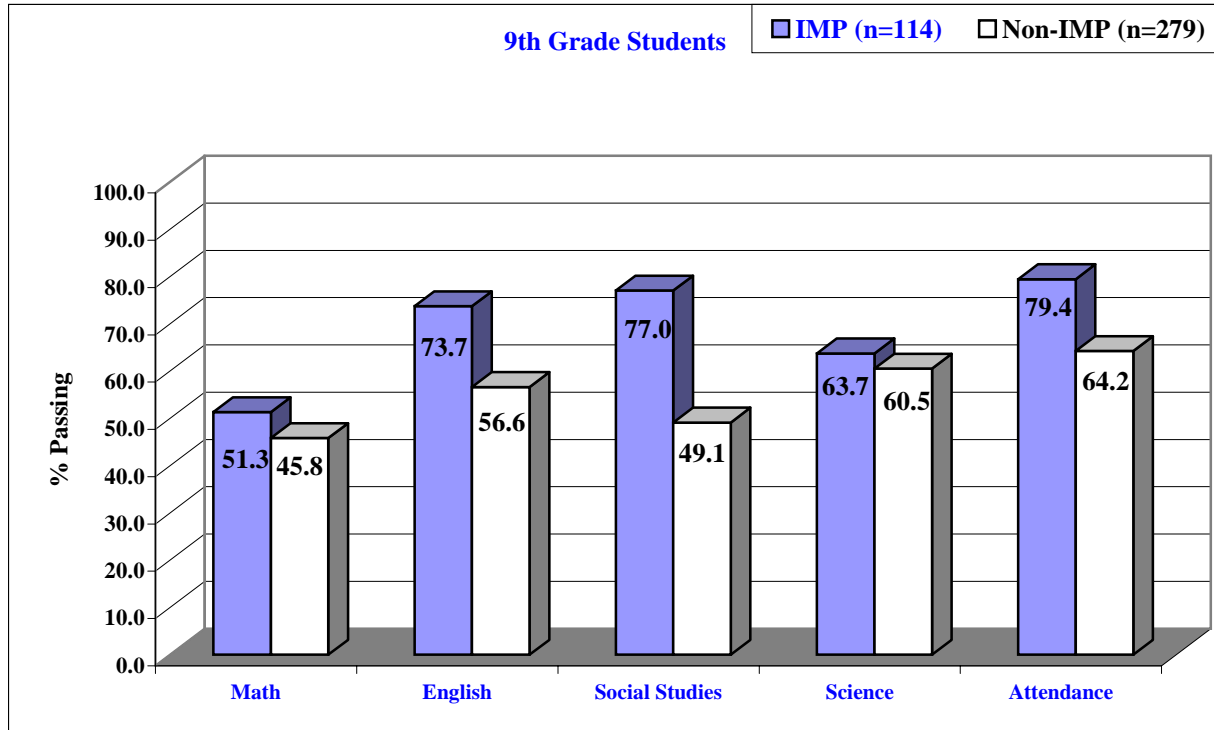
**BARTRAM HIGH SCHOOL**  
**IMP vs. Non-IMP Students**  
Fourth Report Period -- June 1997



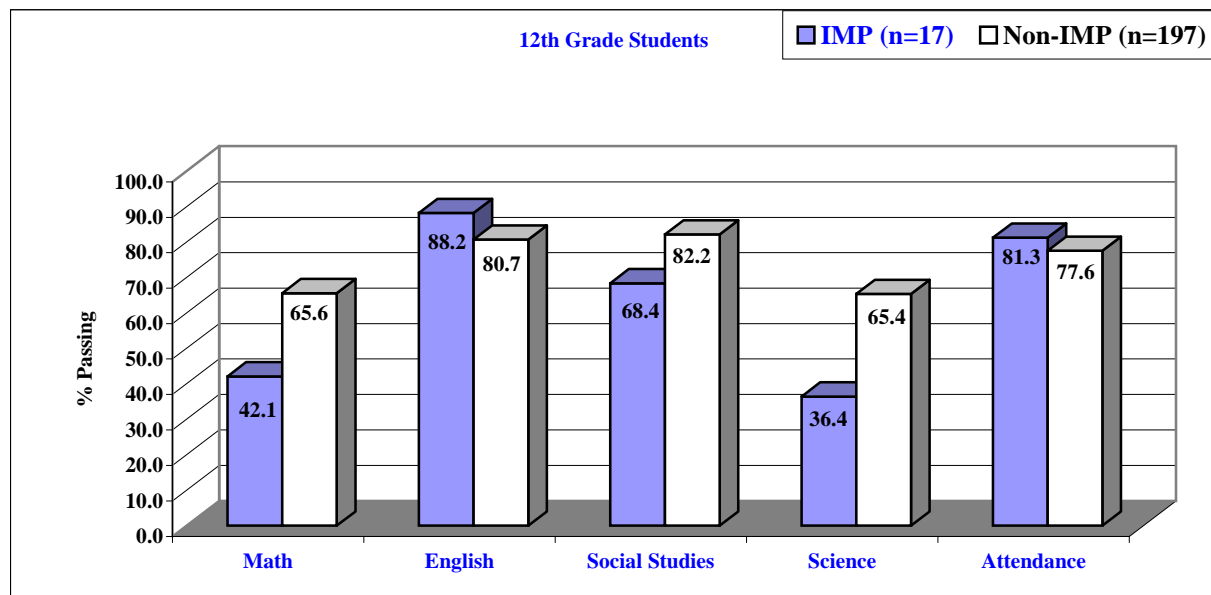
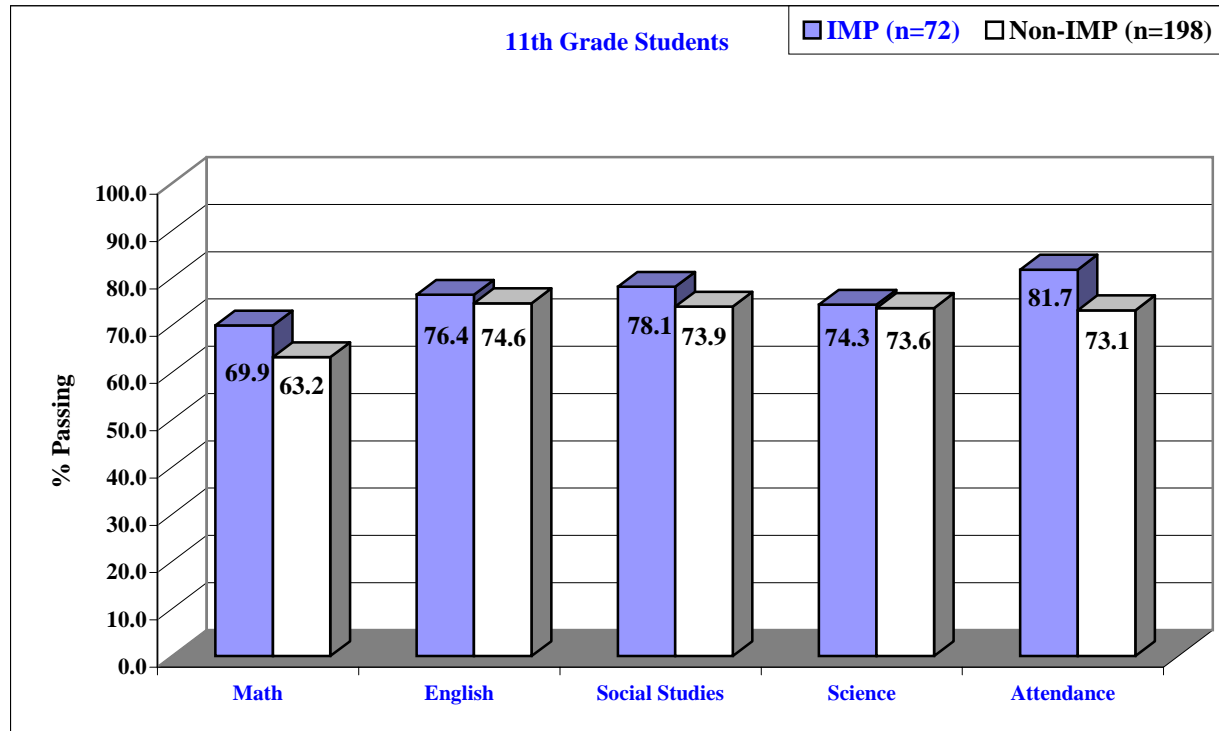
**BARTRAM HIGH SCHOOL**  
**IMP vs. Non-IMP Students**  
**Fourth Report Period -- June 1997**



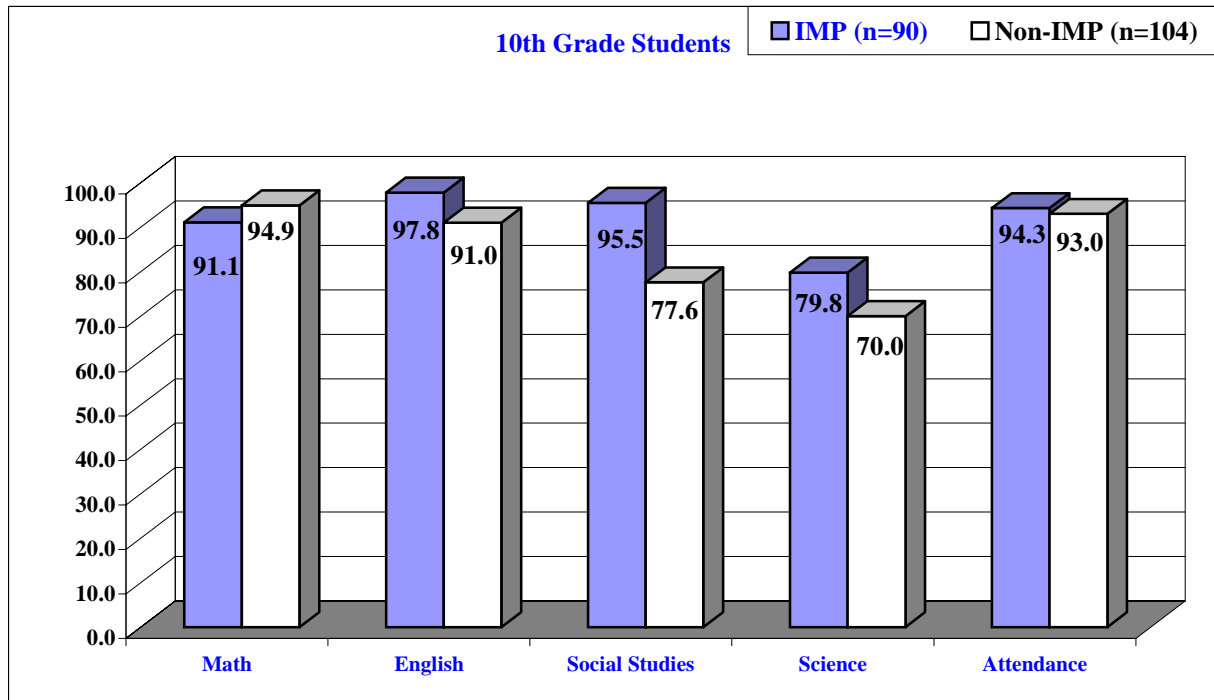
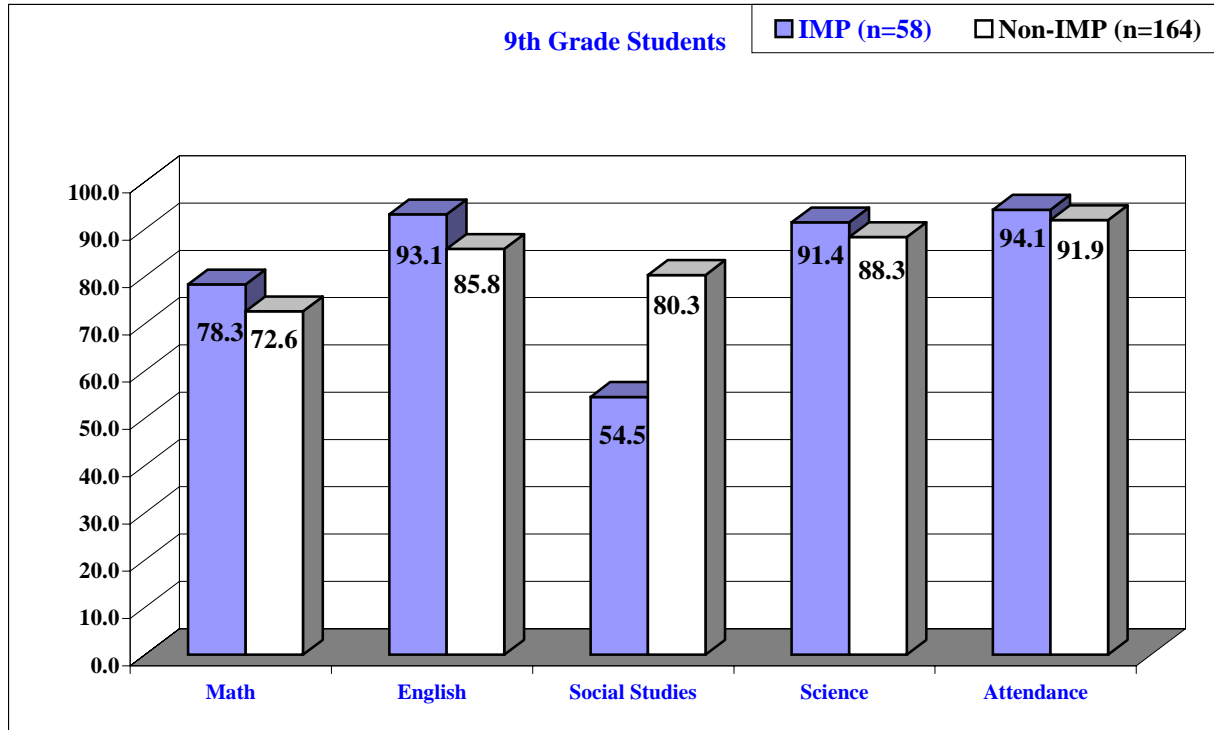
**BEN FRANKLIN HIGH SCHOOL**  
**IMP vs. Non-IMP Students**  
**Fourth Report Period -- June 1997**



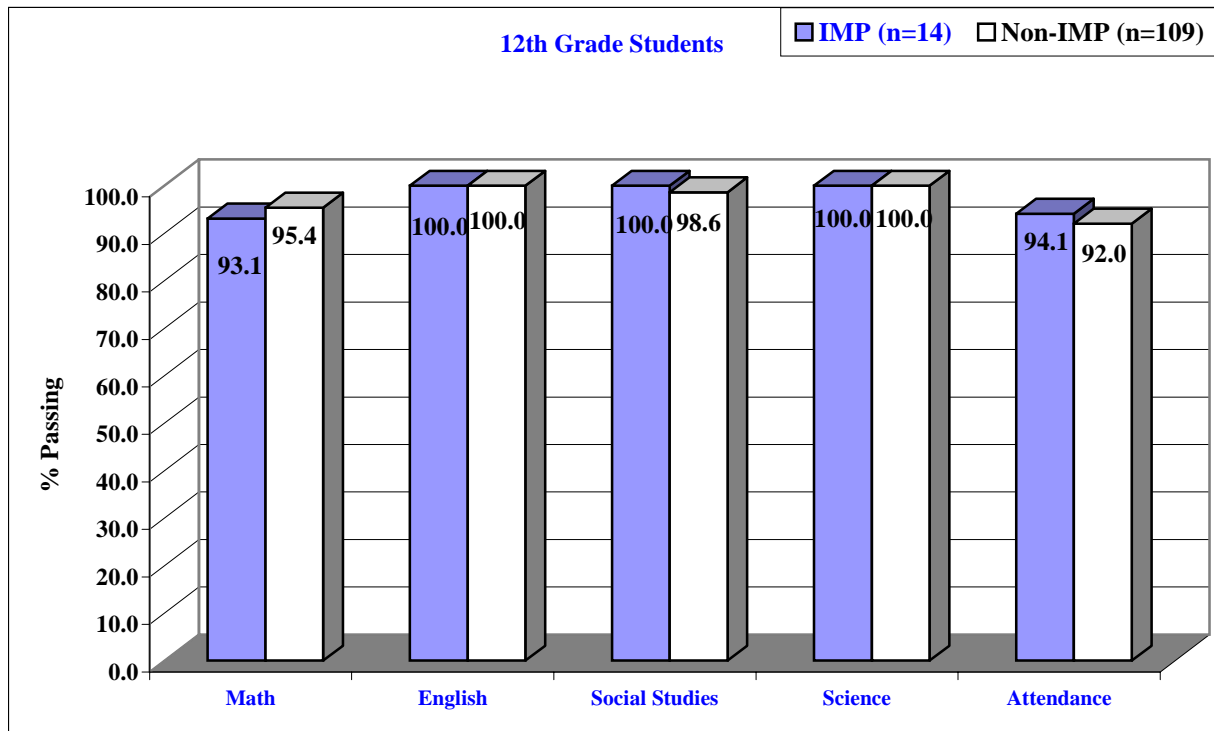
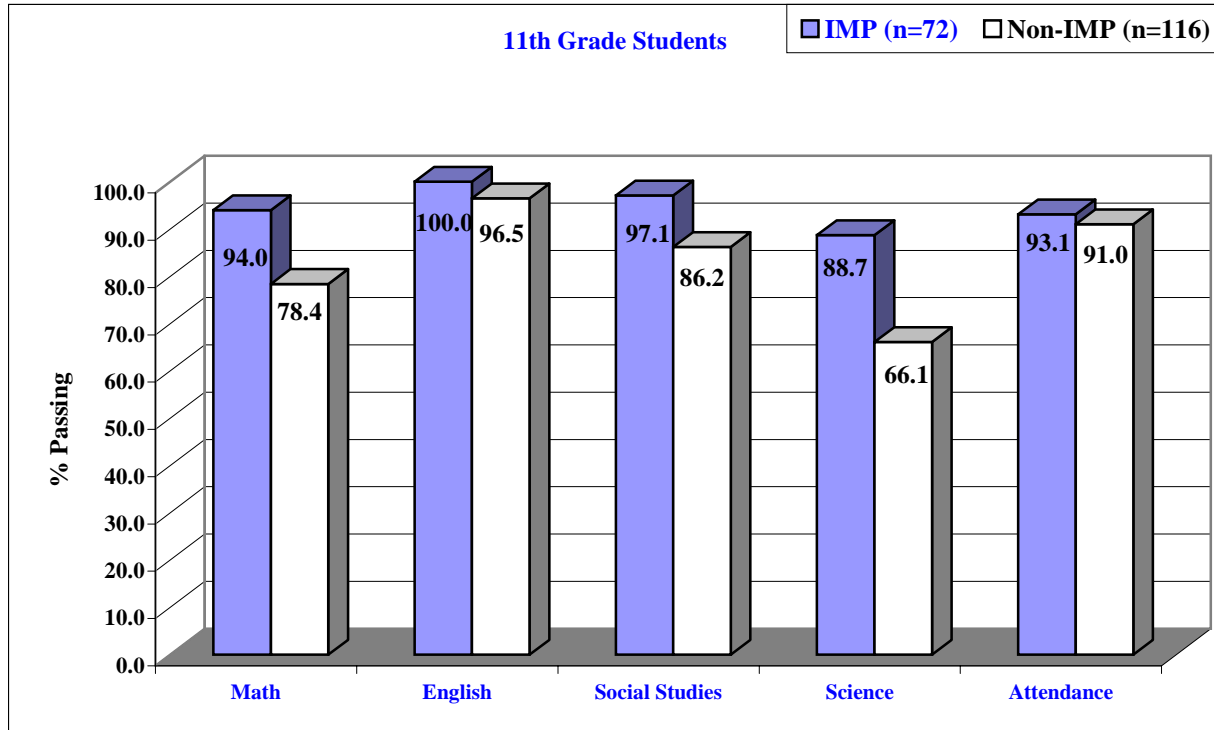
**BEN FRANKLIN HIGH SCHOOL**  
**IMP vs. Non-IMP Students**  
**Fourth Report Period -- June 1997**



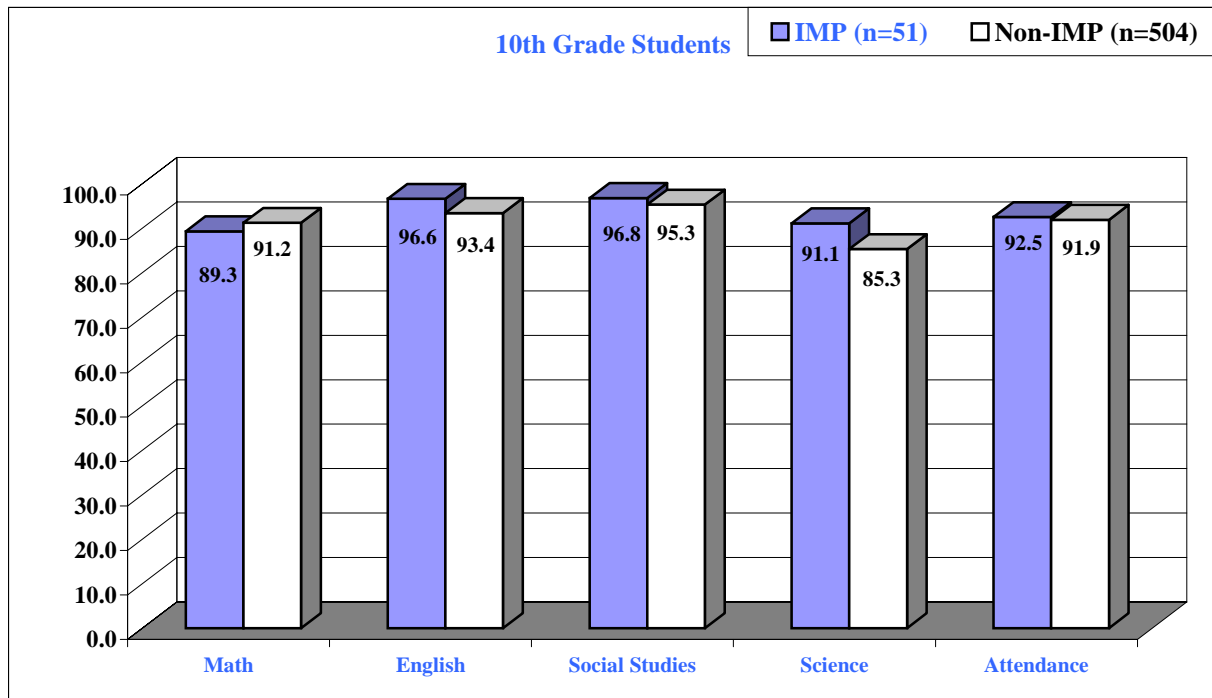
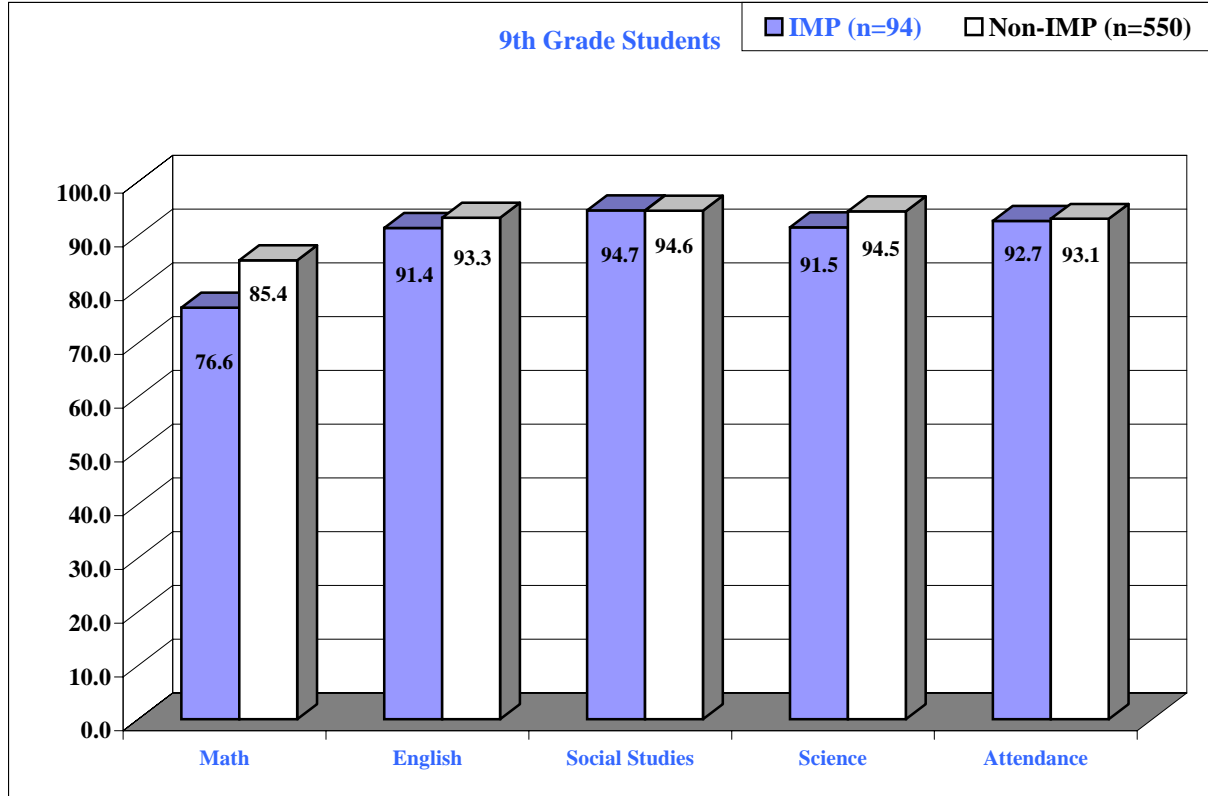
**CARVER HIGH SCHOOL**  
**IMP vs. Non-IMP Students**  
**Fourth Report Period -- June 1997**



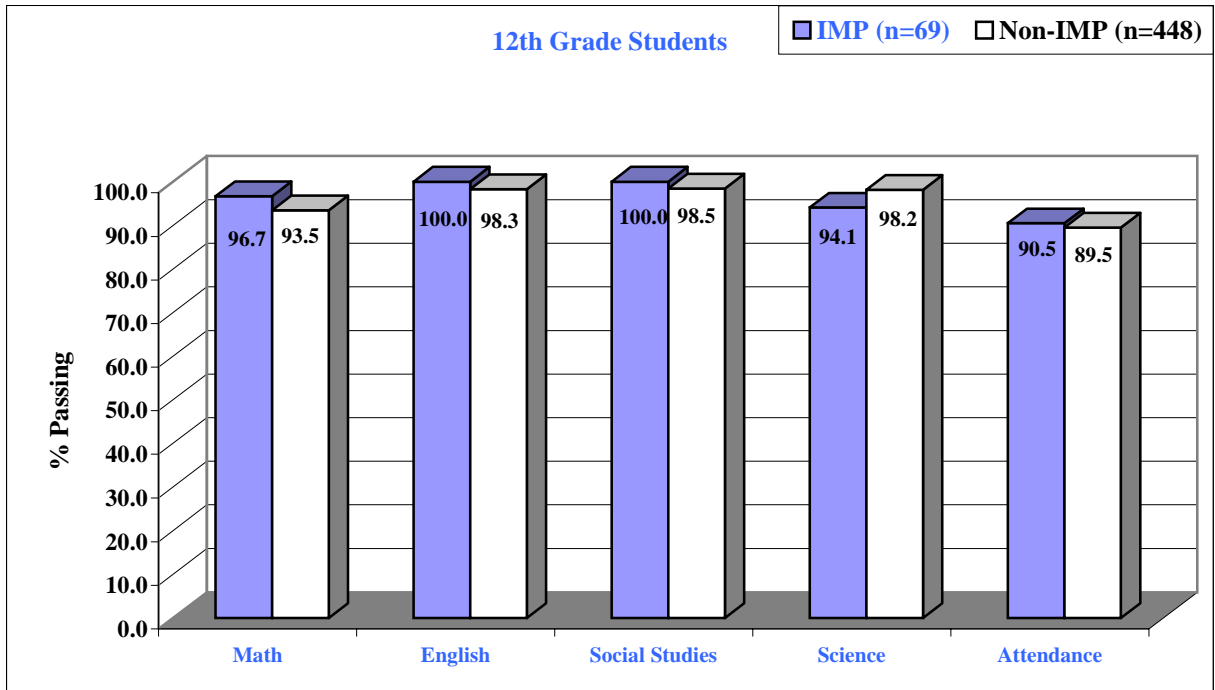
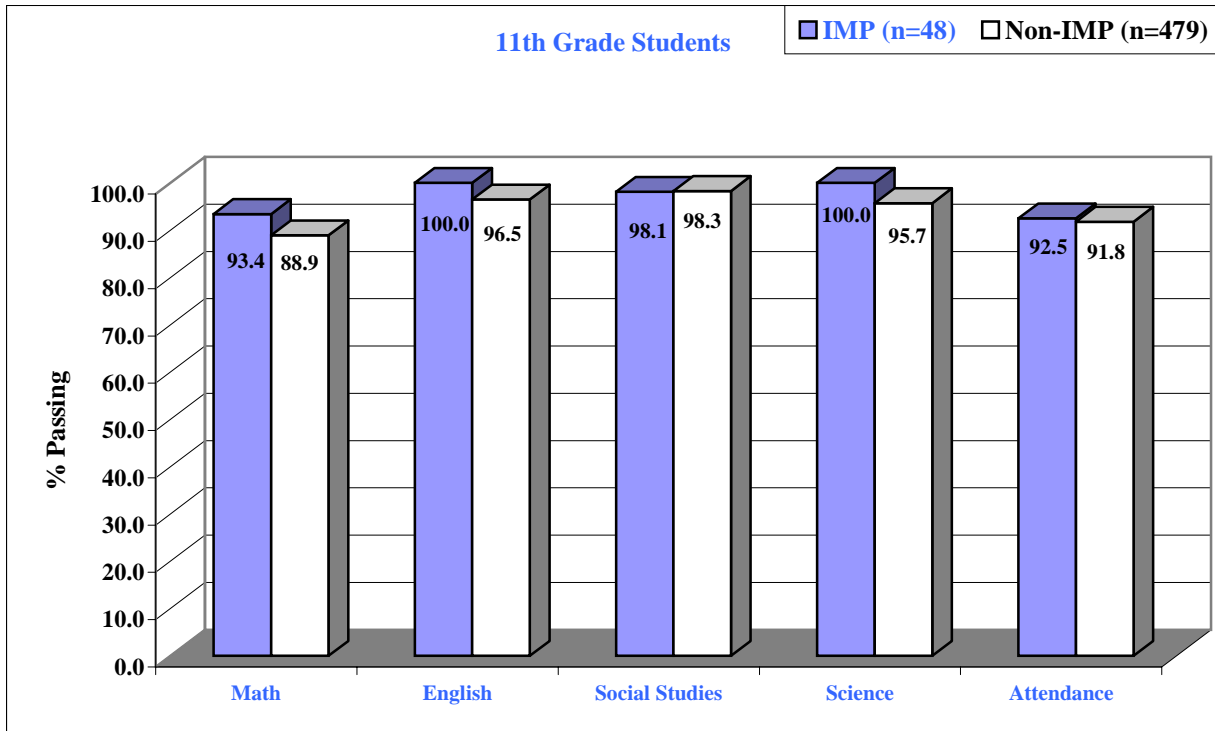
**CARVER HIGH SCHOOL**  
**IMP vs. Non-IMP Students**  
**Fourth Report Period -- June 1997**



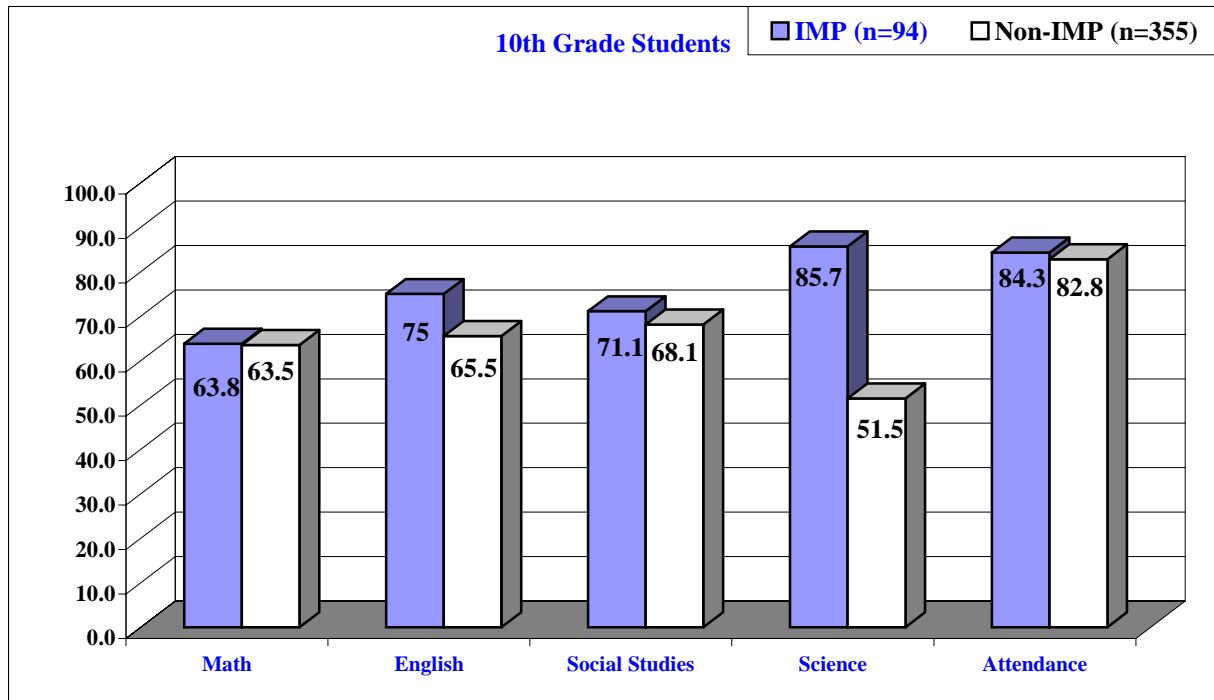
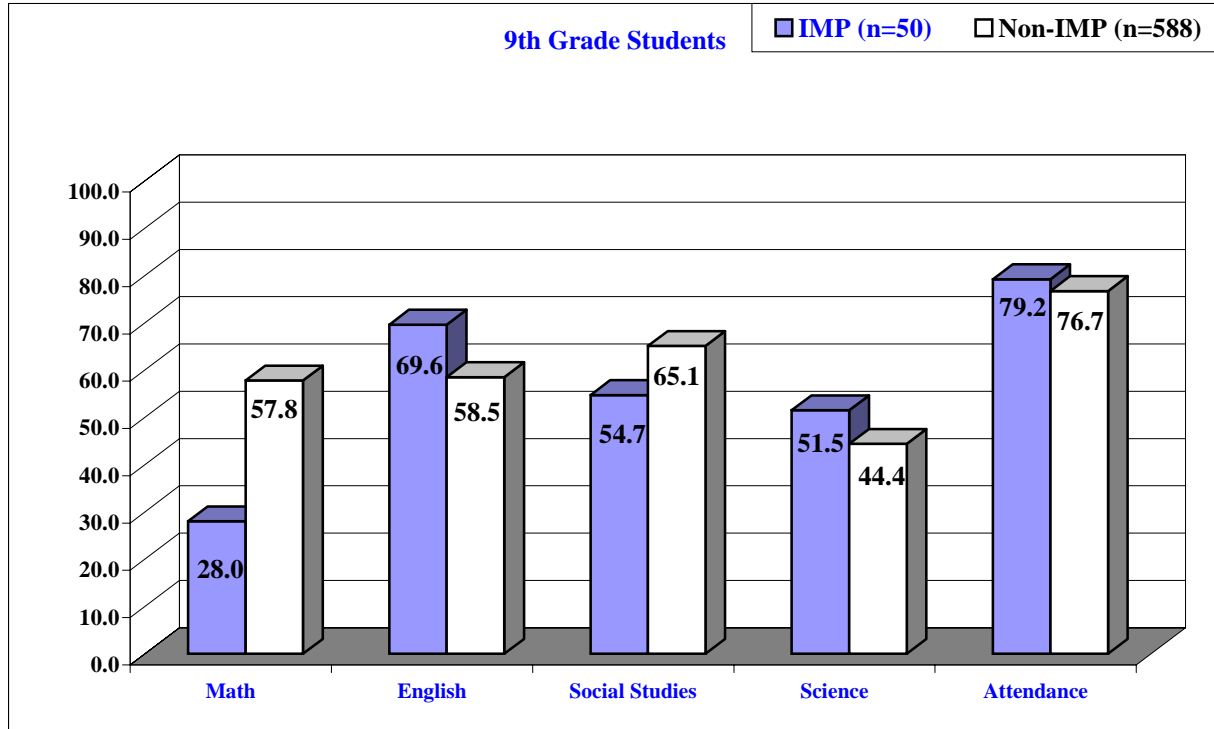
**CENTRAL HIGH SCHOOL**  
**IMP vs. Non-IMP Students**  
**Fourth Report Period -- June 1997**



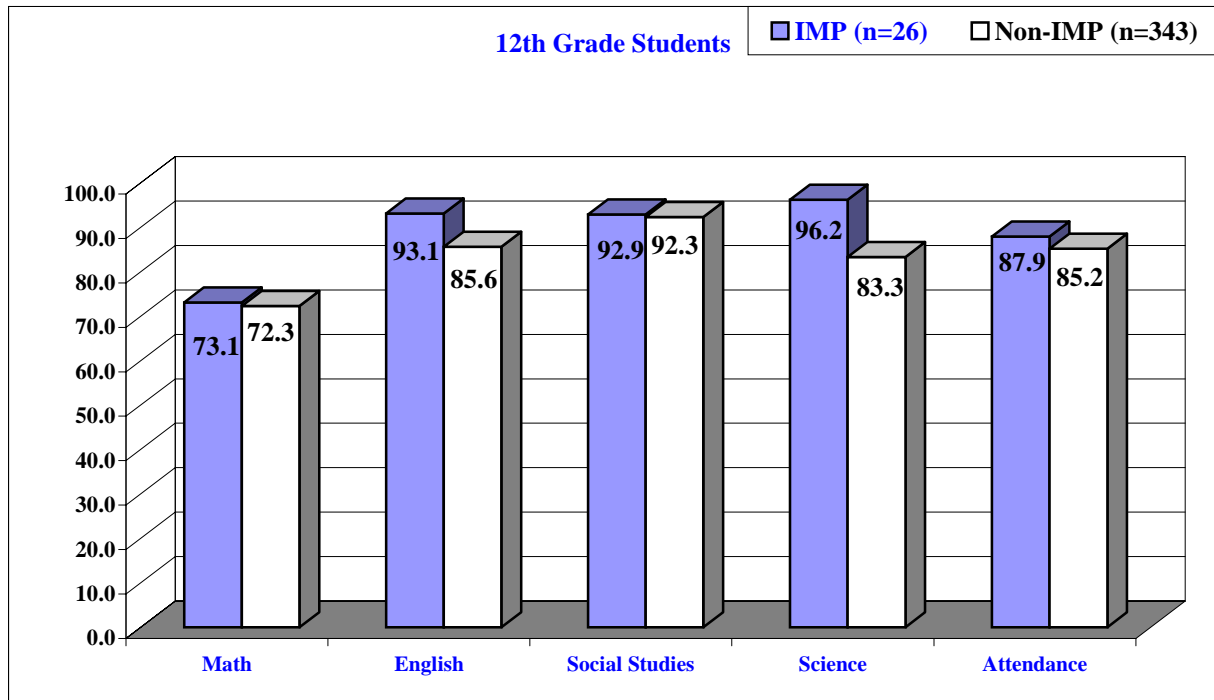
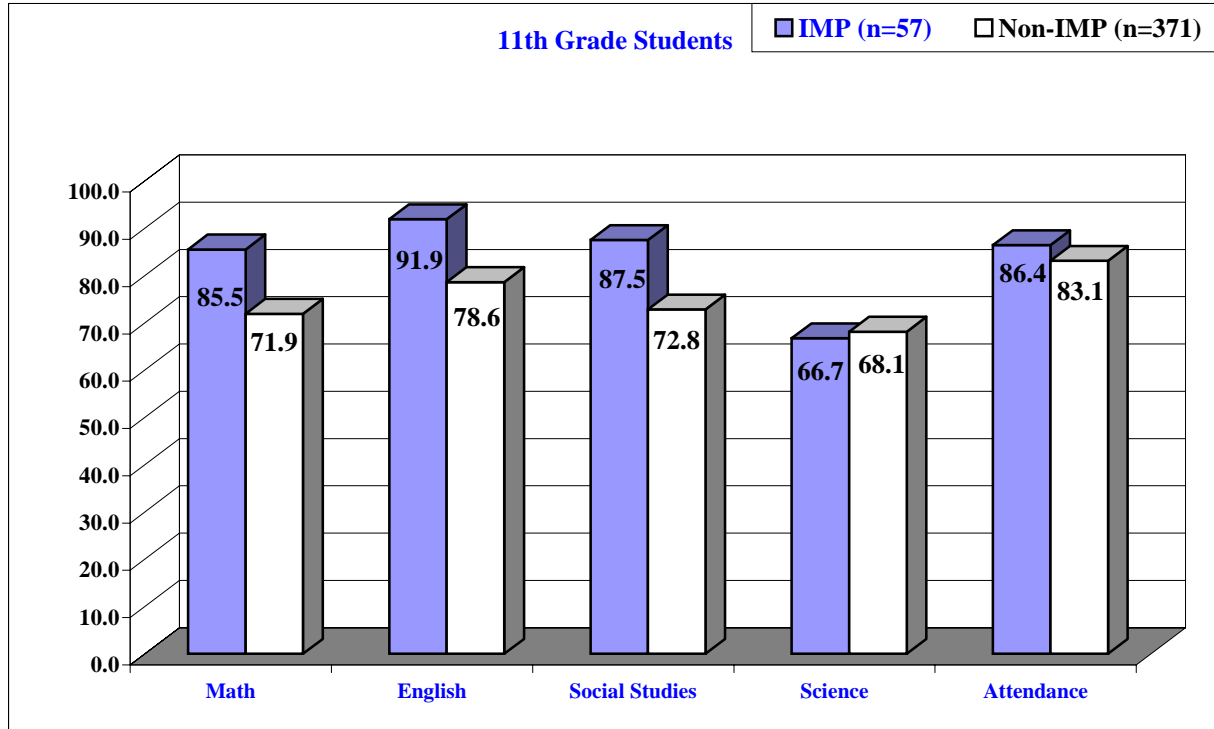
**CENTRAL HIGH SCHOOL**  
**IMP vs. Non-IMP Students**  
Fourth Report Period -- June 1997



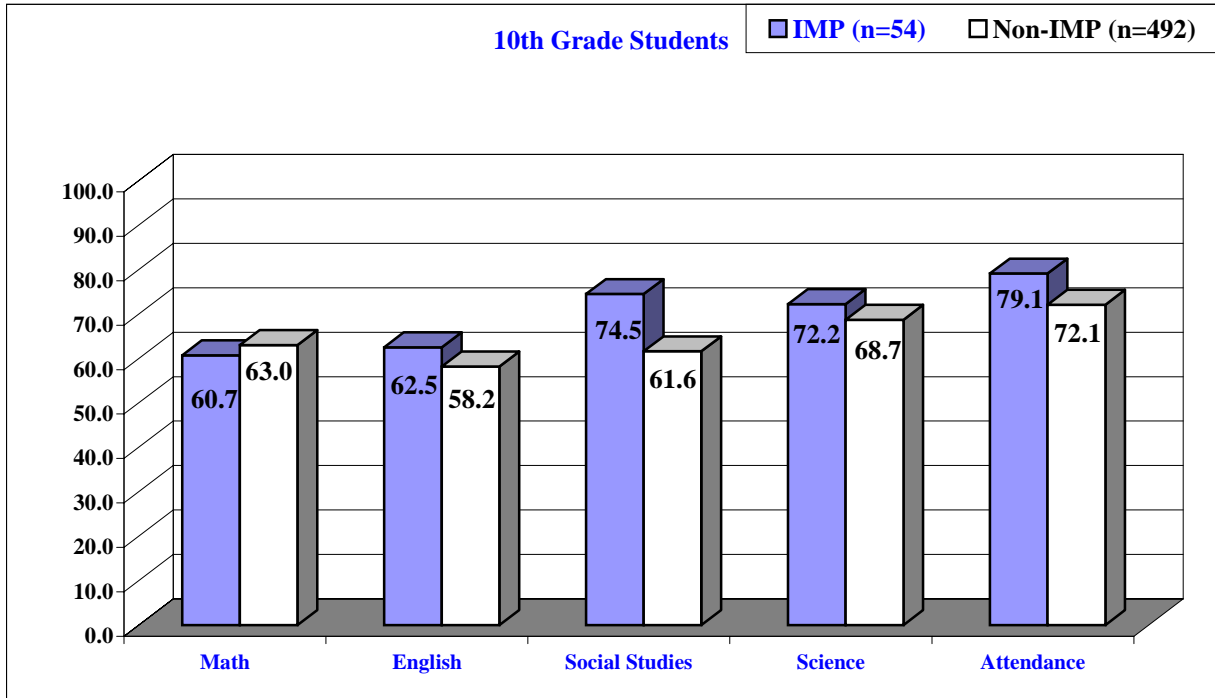
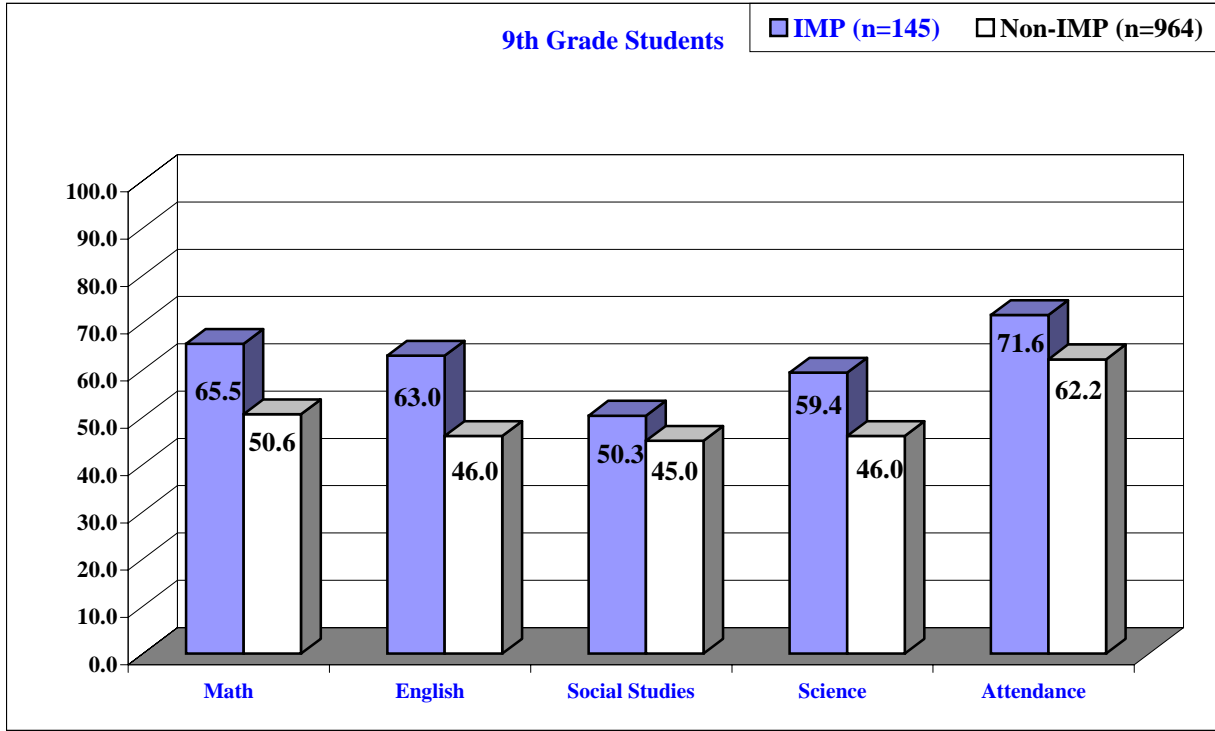
**DOBBINS AVT HIGH SCHOOL**  
**IMP vs. Non-IMP Students**  
**Fourth Report Period -- June 1997**



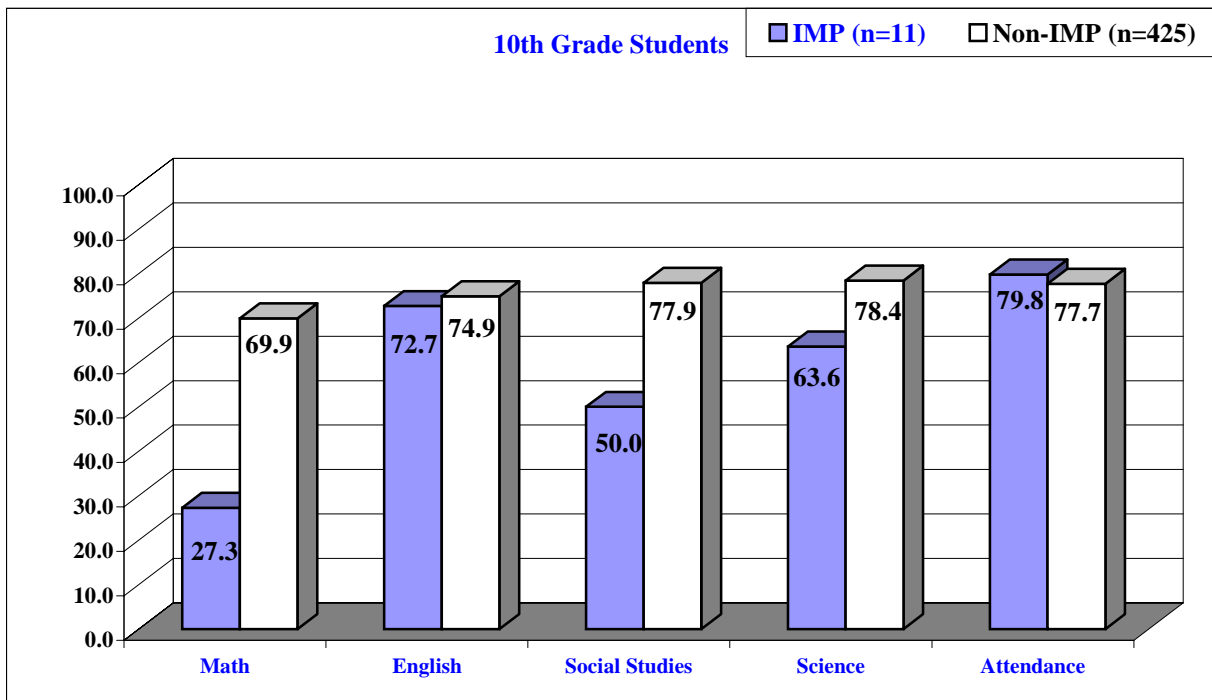
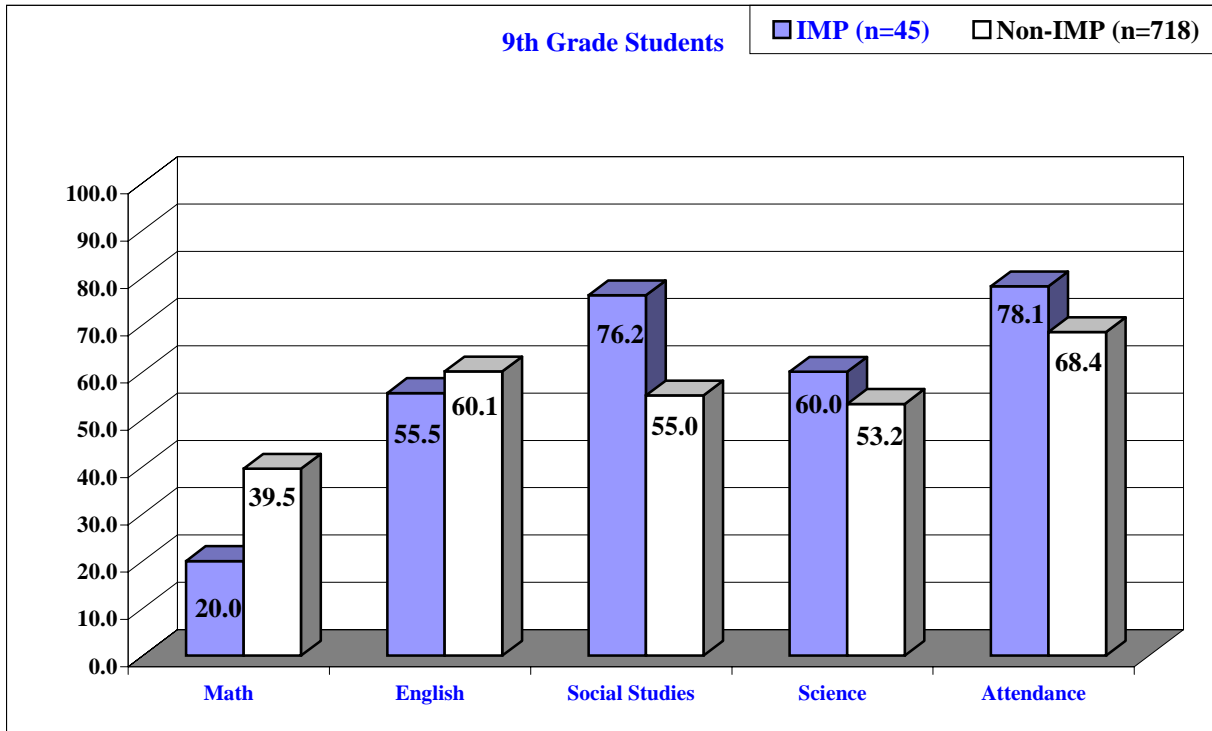
**DOBBINS AVT HIGH SCHOOL**  
**IMP vs. Non-IMP Students**  
**Fourth Report Period -- June 1997**



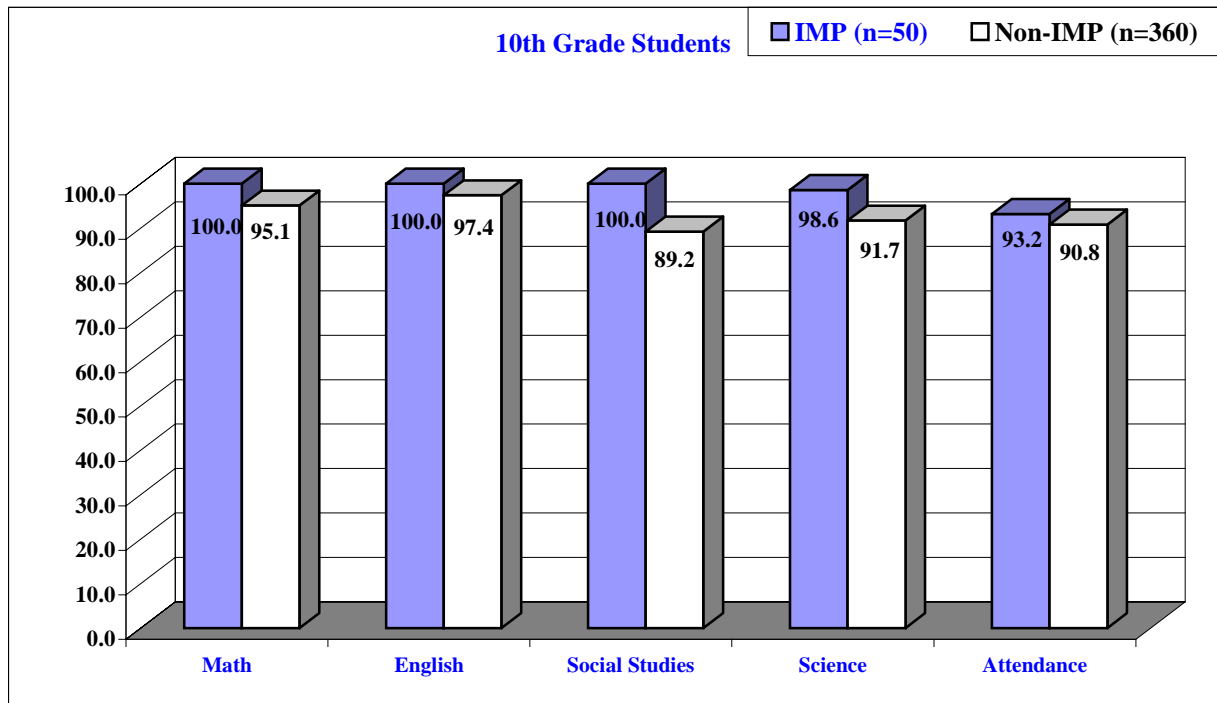
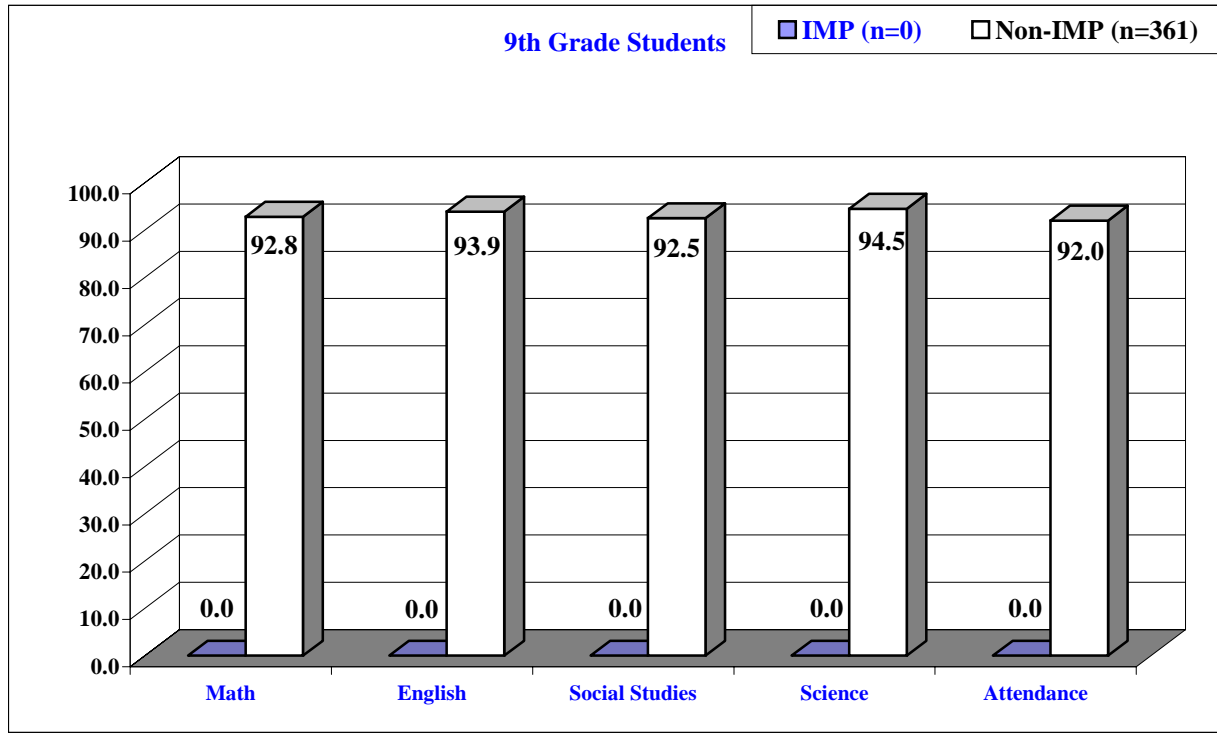
**EDISON HIGH SCHOOL**  
**IMP vs. Non-IMP Students**  
Fourth Report Period -- June 1997



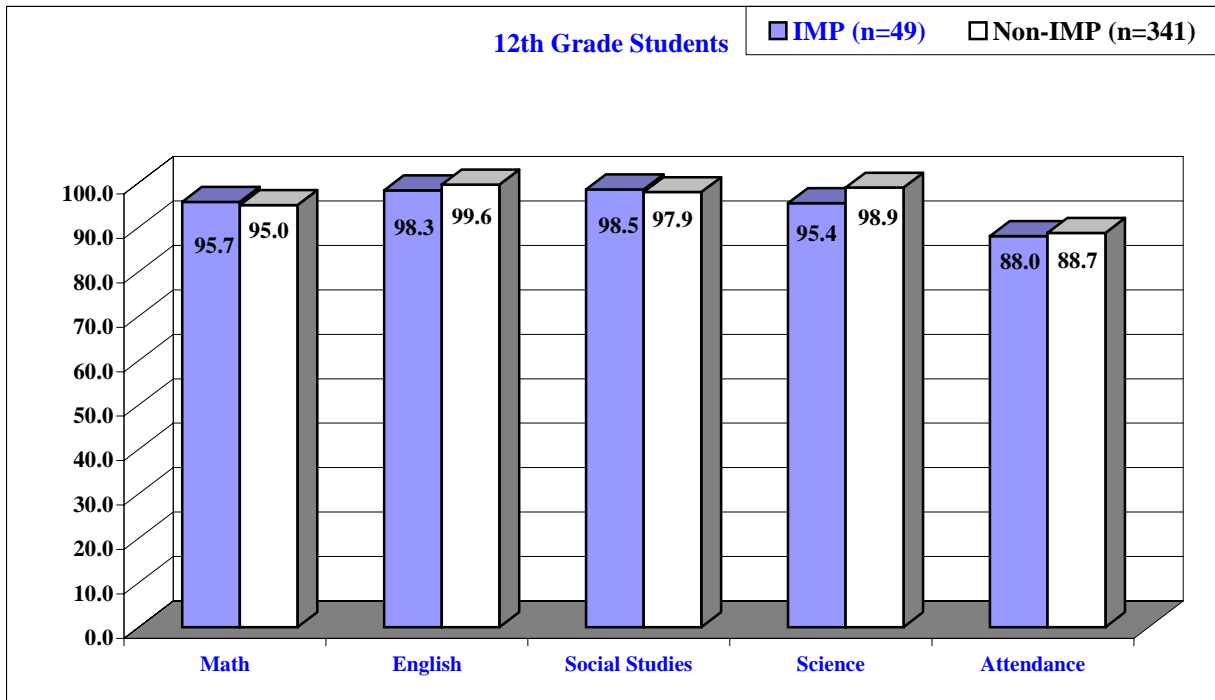
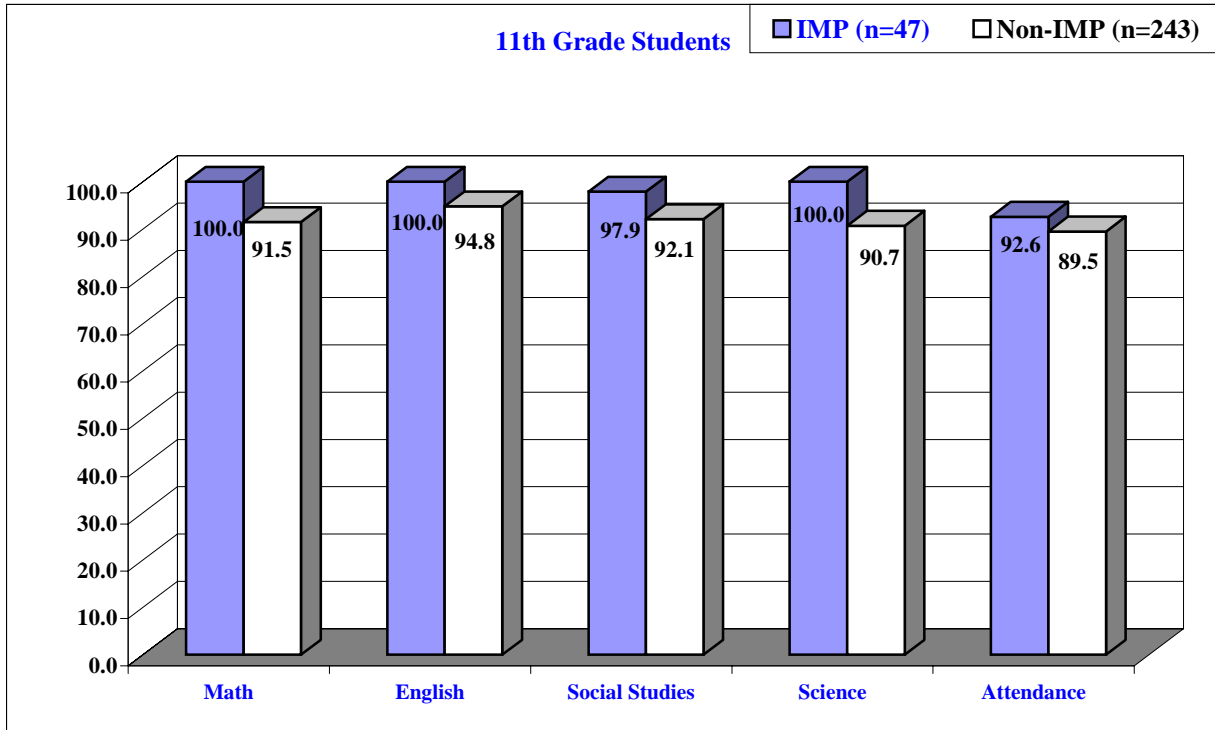
**GERMANTOWN HIGH SCHOOL**  
**IMP vs. Non-IMP Students**  
 Fourth Report Period -- June 1997



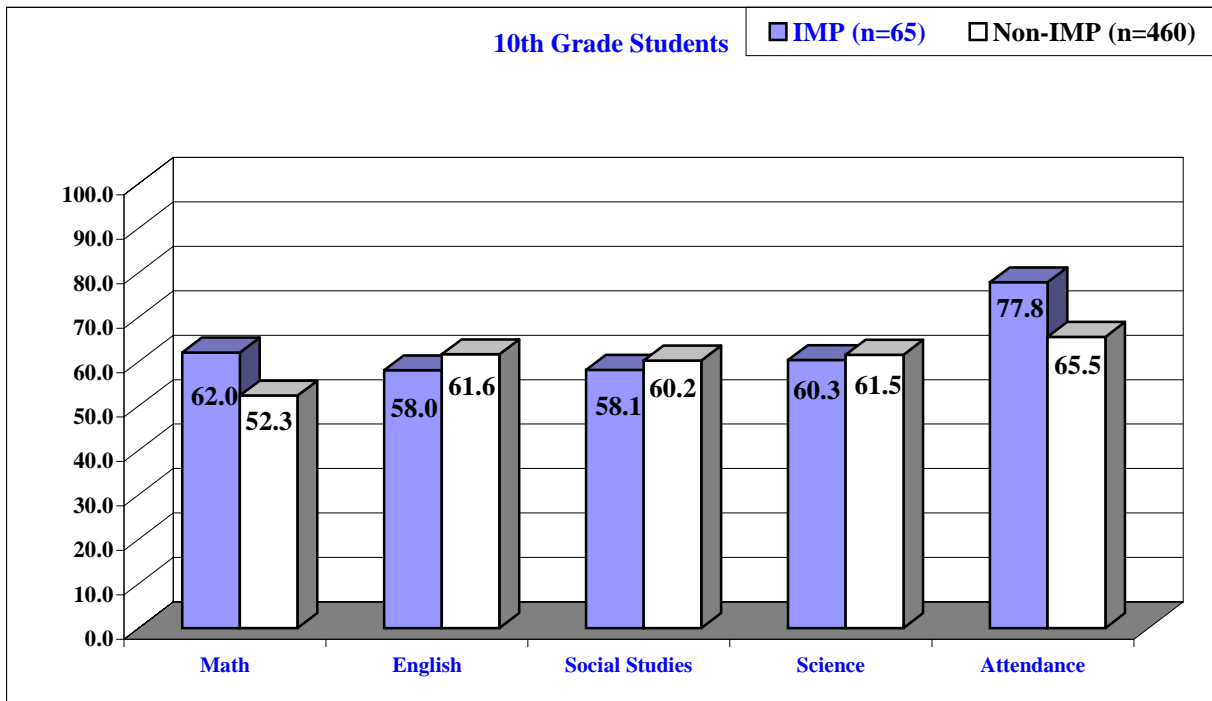
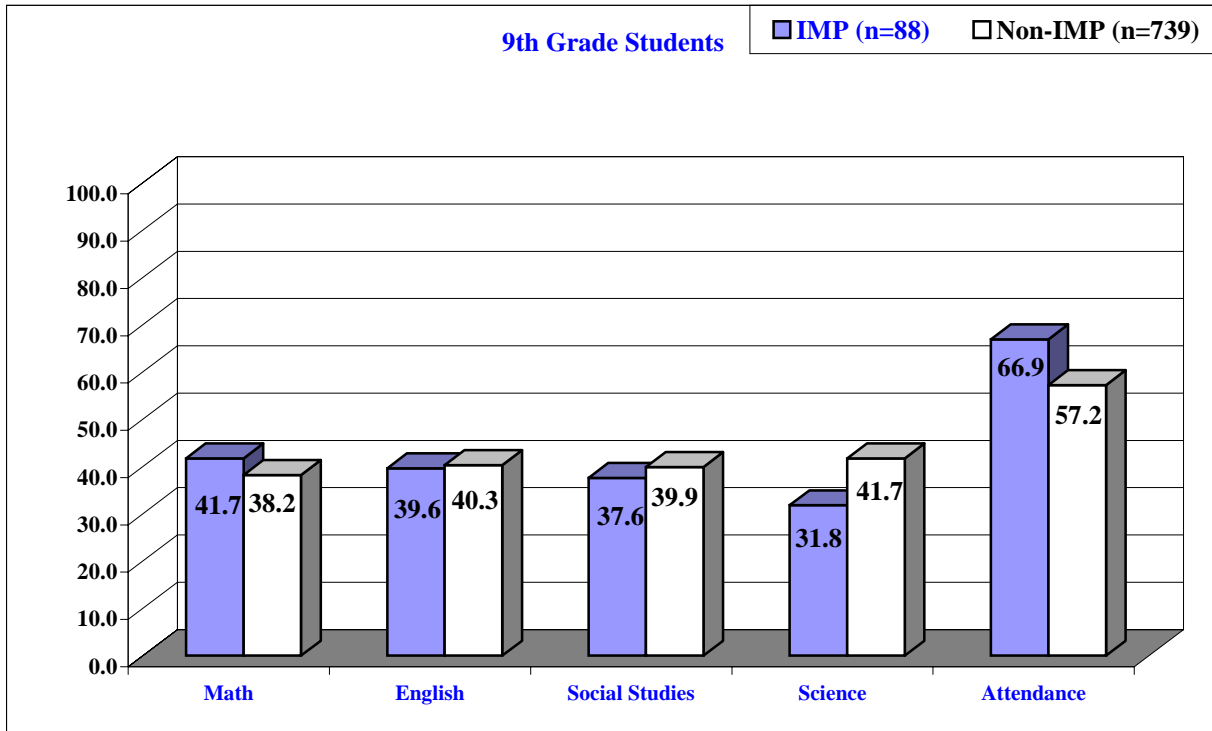
**GIRLS' HIGH SCHOOL**  
**IMP vs. Non-IMP Students**  
 Fourth Report Period -- June 1997



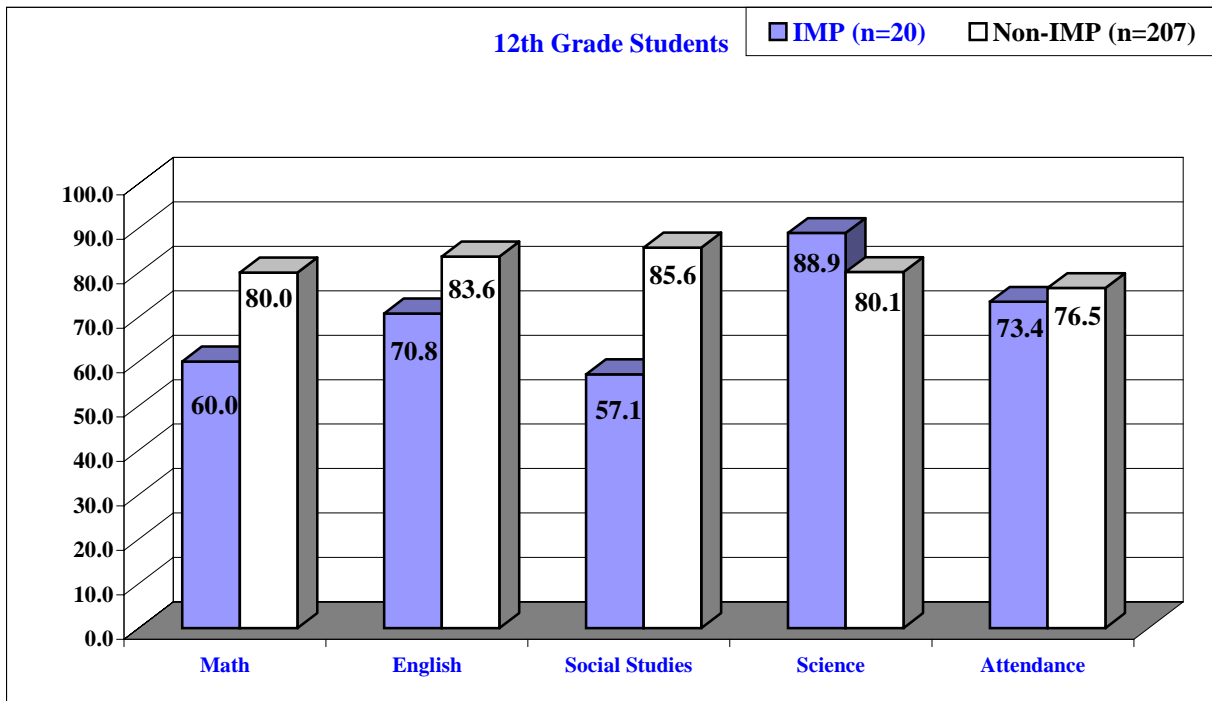
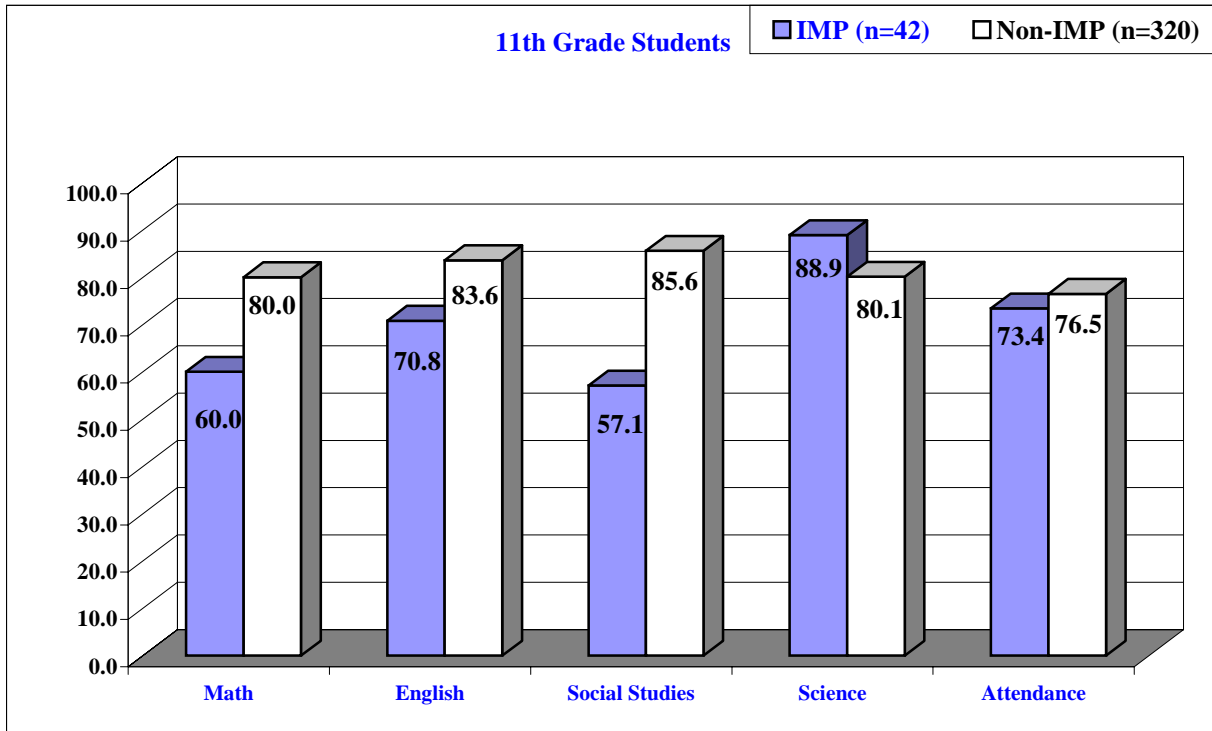
**GIRLS' HIGH SCHOOL**  
**IMP vs. Non-IMP Students**  
Fourth Report Period -- June 1997



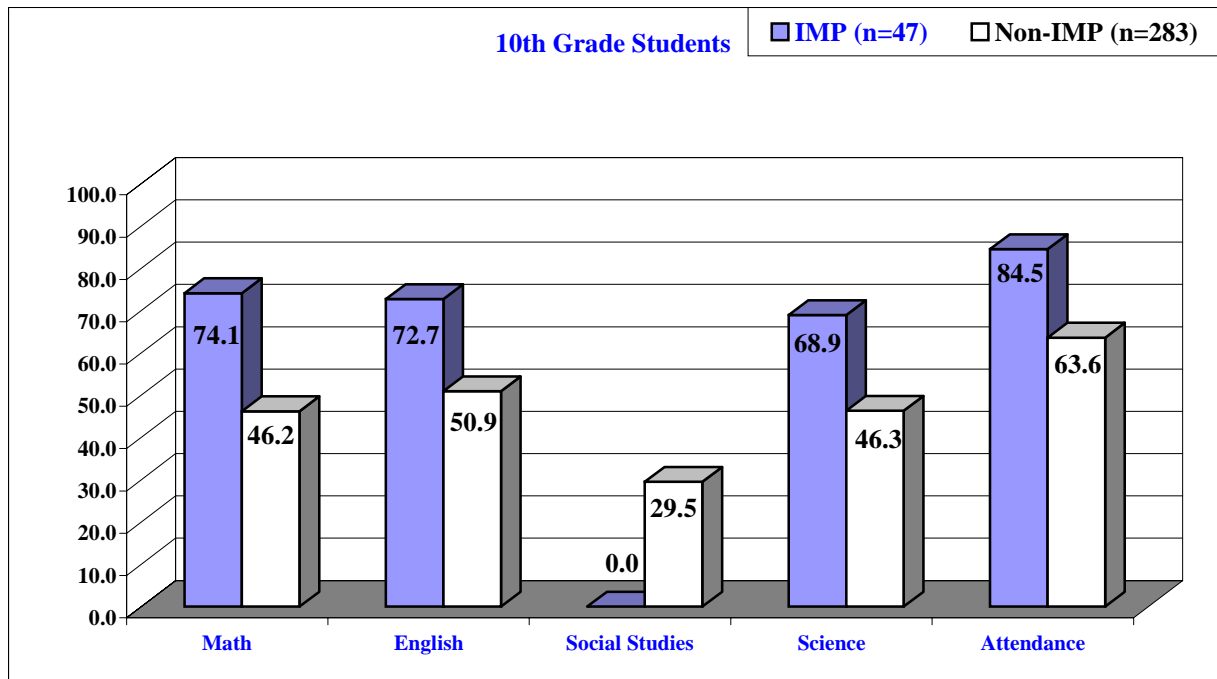
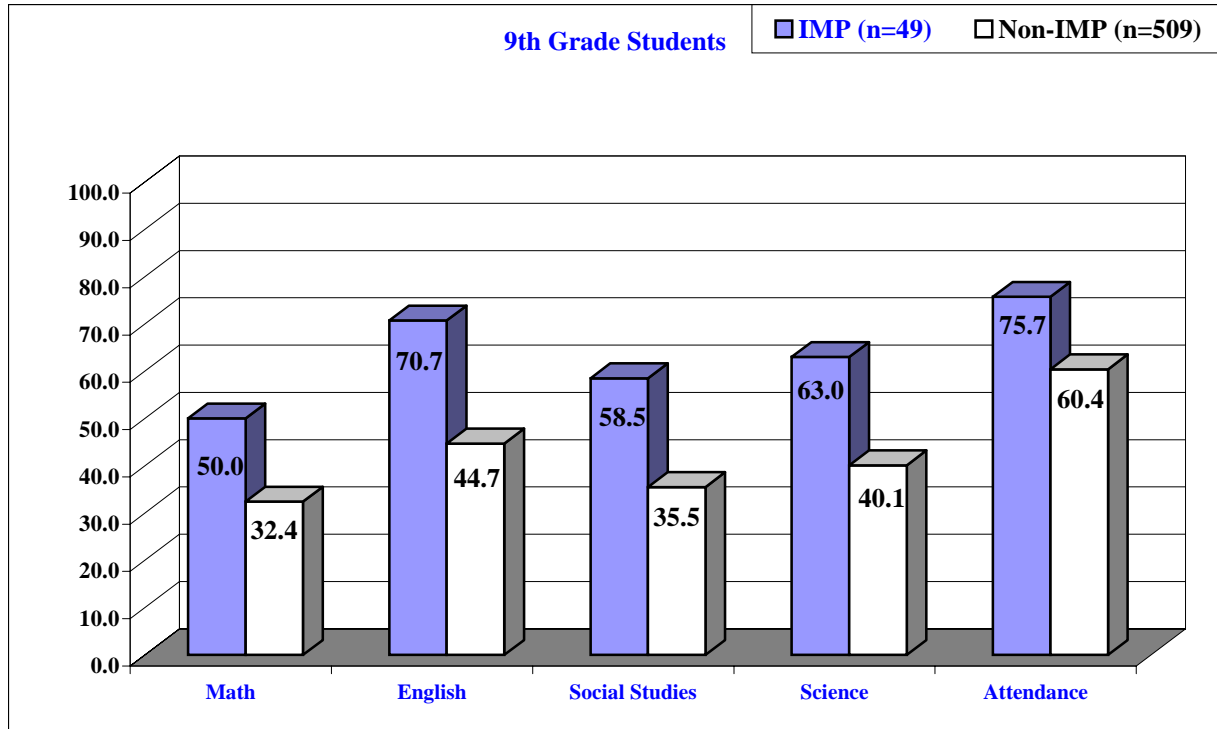
**GRATZ HIGH SCHOOL**  
**IMP vs. Non-IMP Students**  
Fourth Report Period -- June 1997



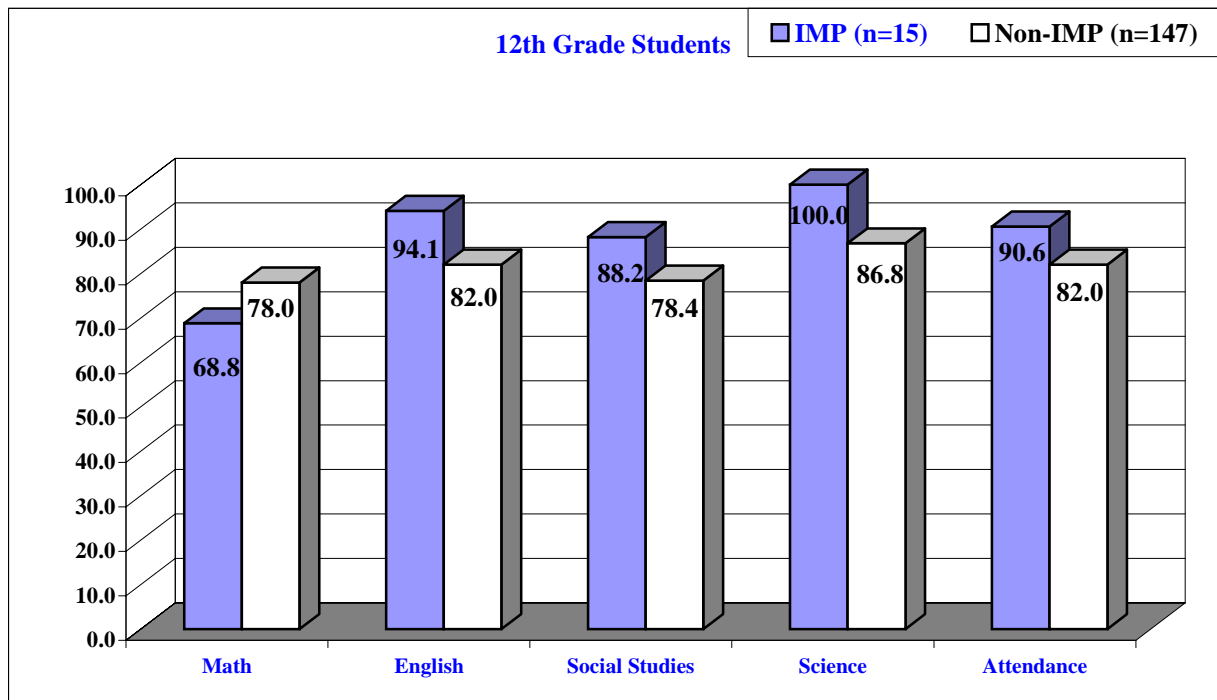
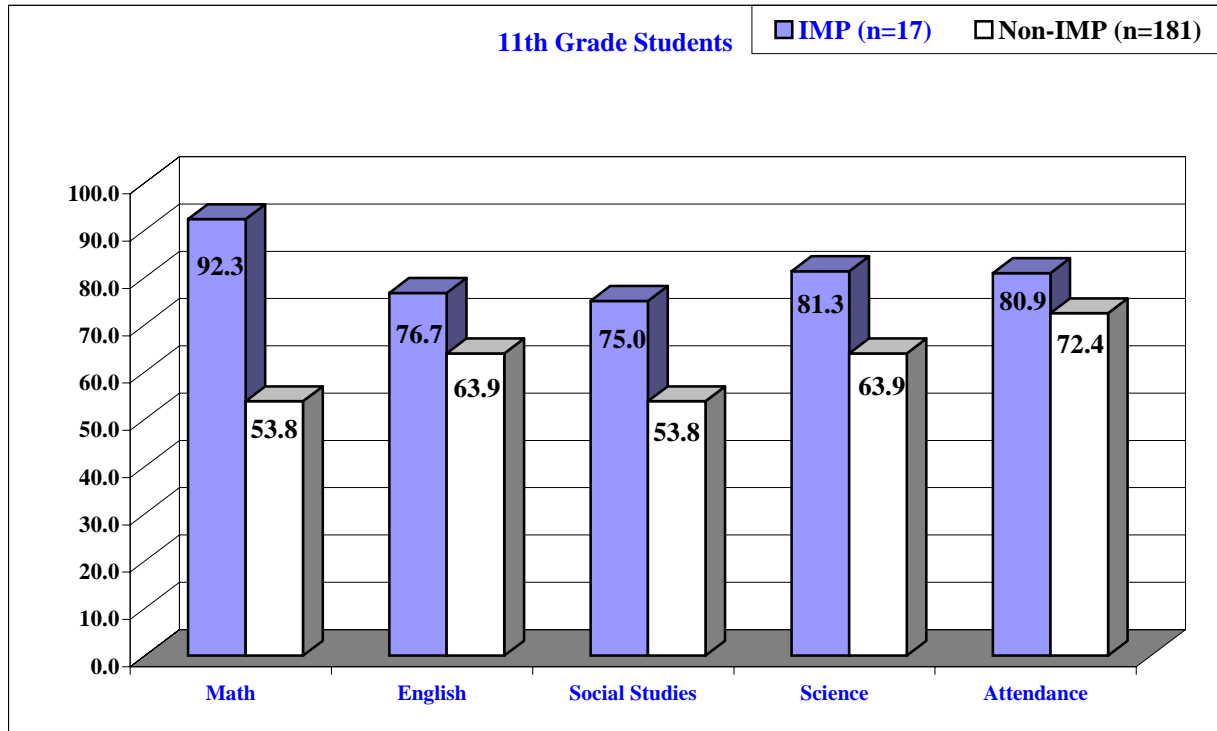
**GRATZ HIGH SCHOOL**  
**IMP vs. Non-IMP Students**  
Fourth Report Period -- June 1997



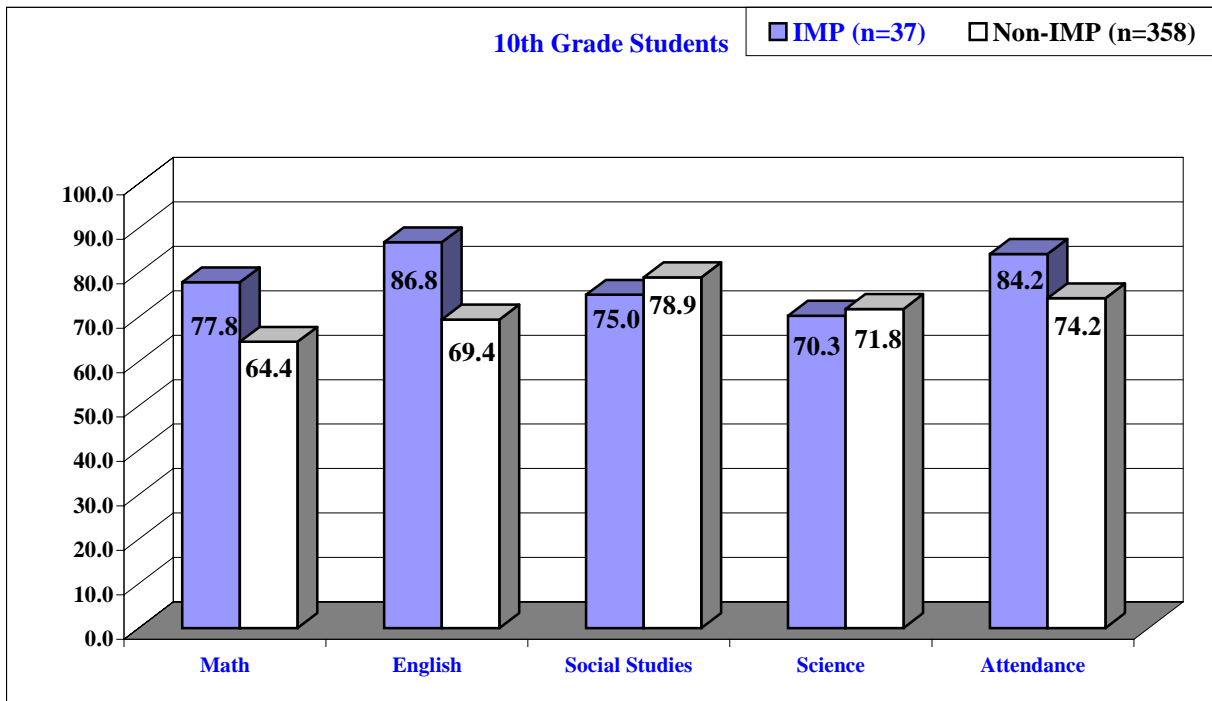
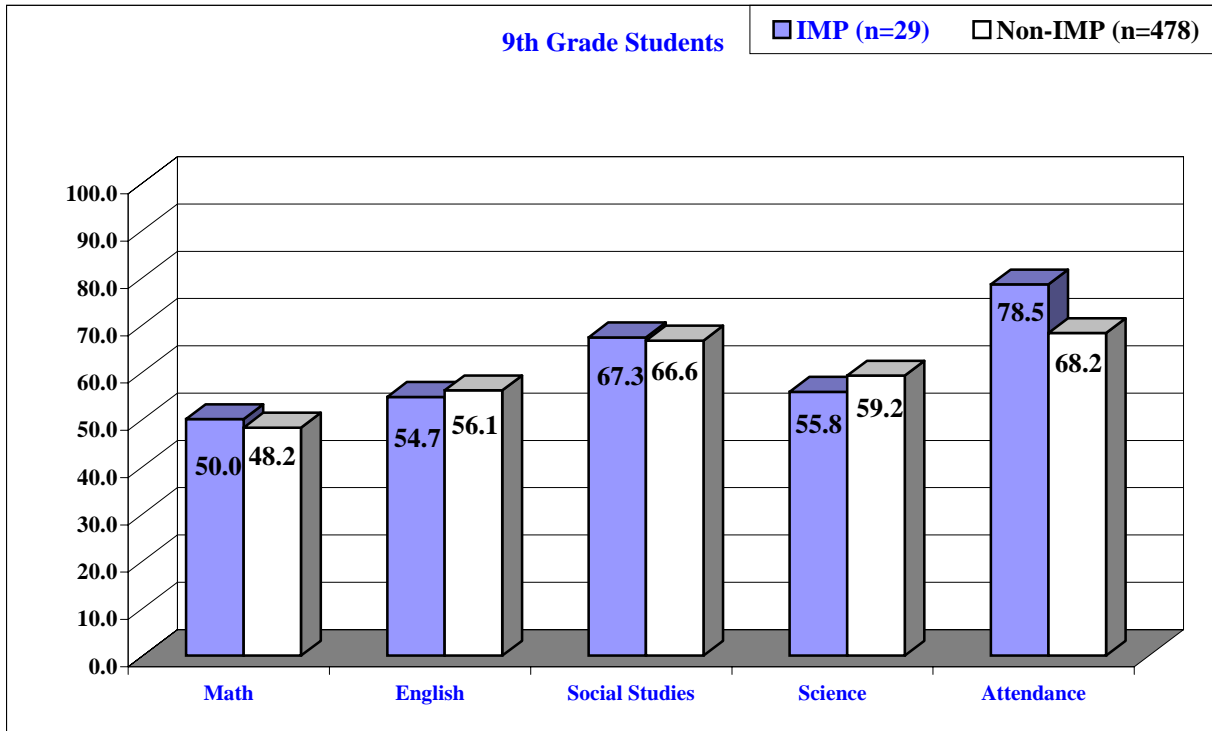
**STRAWBERRY MANSION HIGH SCHOOL**  
**IMP vs. Non-IMP Students**  
 Fourth Report Period -- June 1997



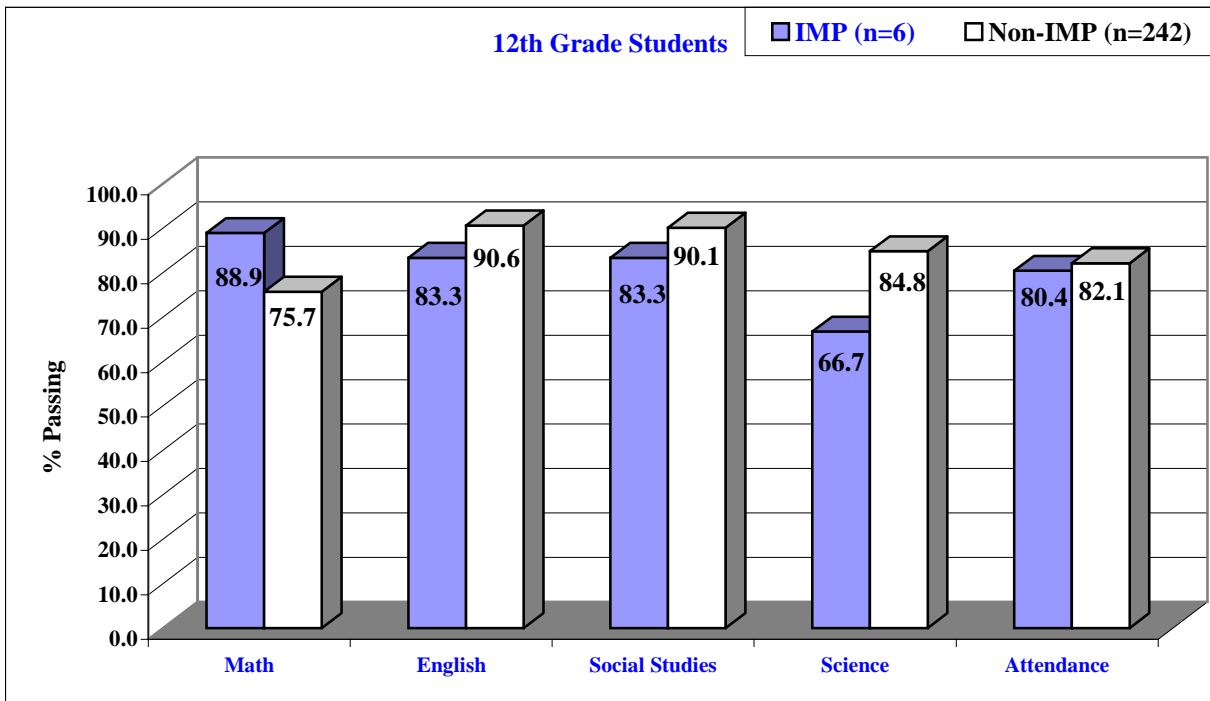
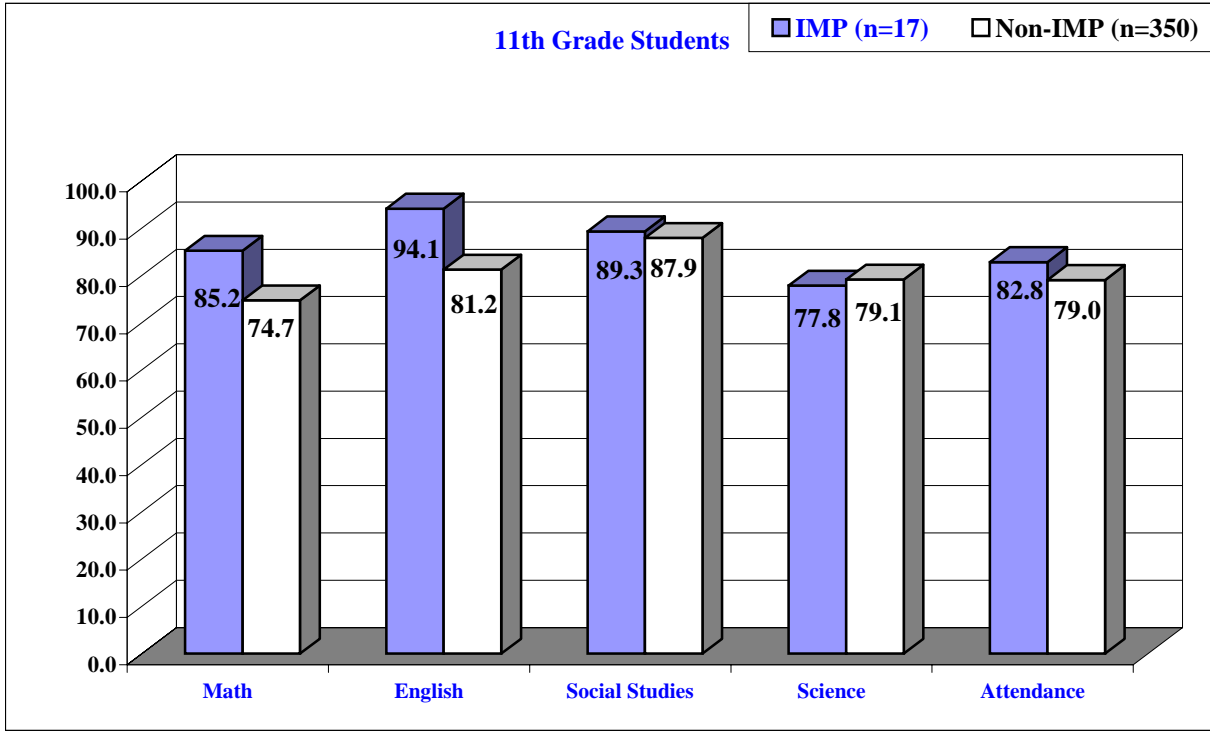
**STRAWBERRY MANSION HIGH SCHOOL**  
**IMP vs. Non-IMP Students**  
Fourth Report Period -- June 1997



**UNIVERSITY CITY HIGH SCHOOL**  
**IMP vs. Non-IMP Students**  
Fourth Report Period -- June 1997



**UNIVERSITY CITY HIGH SCHOOL**  
**IMP vs. Non-IMP Students**  
 Fourth Report Period -- June 1997



**Test Date: October 1994**  
**Sophomore PSAT Scores**  
**Analyzed by Ned Wolff on 12/14/94**

Samples consisted of all sophomores taking either IMP-2 or Geometry.

**Carver High School of Engineering and Science**

	Sample Size	Verbal	Math
<b>IMP</b>	<b>58</b>	<b>48.81</b>	<b>45.09</b>
Traditional	129	44.43	43.44

Differences in verbal scores were significant,  $p < .01$   
Differences in math scores were not significant,  $p = .16$

**Central High School**

	Sample Size	Verbal	Math
<b>IMP</b>	<b>104</b>	<b>51.4</b>	<b>48.3</b>
Traditional	286	48.7	46.3

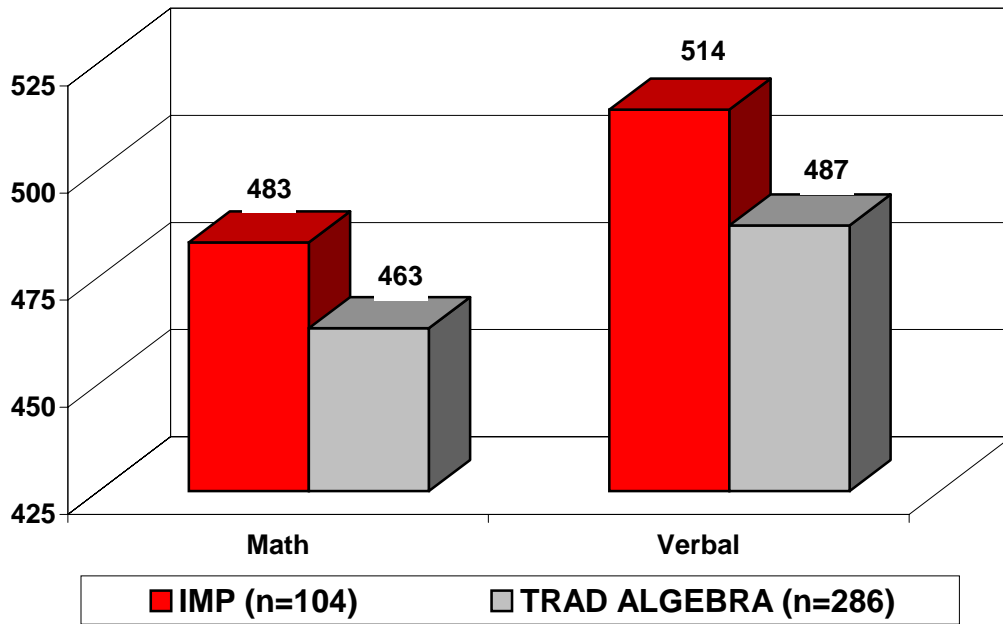
Differences in verbal scores were significant,  $p < .01$   
Differences in math scores were significant,  $p < .01$

**Girls' High School**

	Sample Size	Verbal	Math
<b>IMP</b>	<b>74</b>	<b>45.0</b>	<b>41.1</b>
Traditional	350	43.7	40.2

Differences in verbal scores were not significant,  $p = .15$   
Differences in math scores were not significant,  $p = .26$

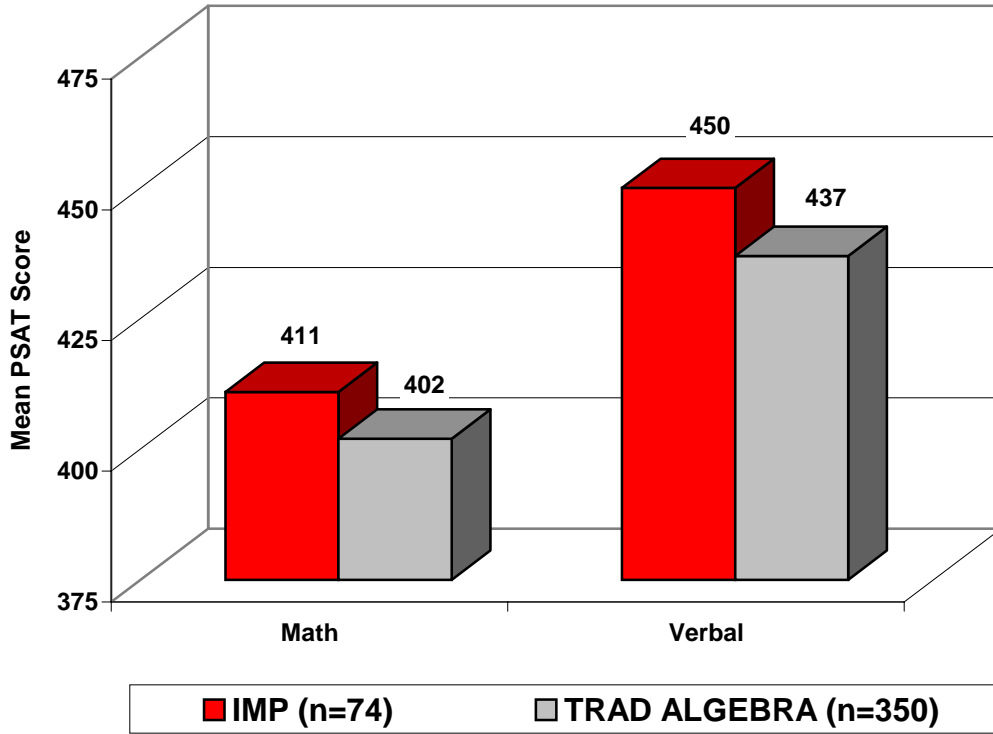
October 1994  
10th Grade  
Analysis of PSAT Data  
Central High School, Philadelphia



Scores from the OCTOBER 1994 test administration of:

- 104 IMP2 10th grade students
- 286 Traditional math 10th grade students (Algebra in 9th grade and Geometry in 10th grade)

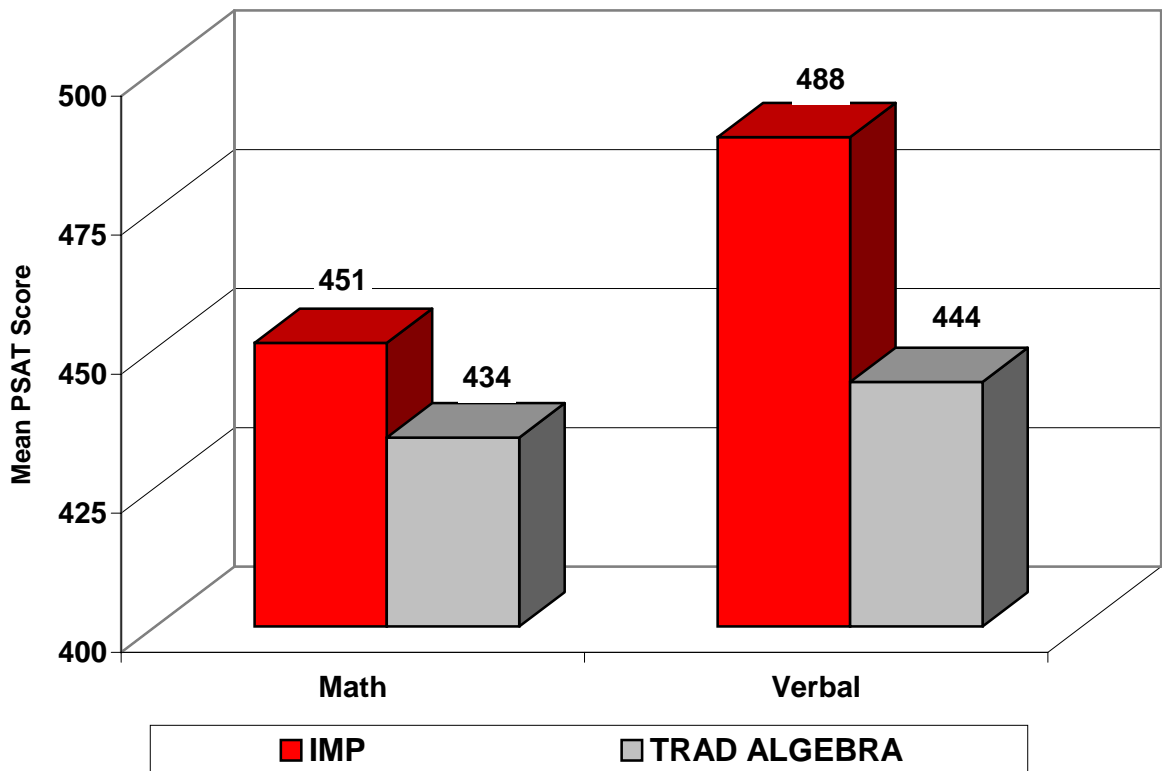
October 1994  
10th Grade  
Analysis of PSAT Data  
Girls' High School, Philadelphia



Scores from the OCTOBER 1994 test administration of:

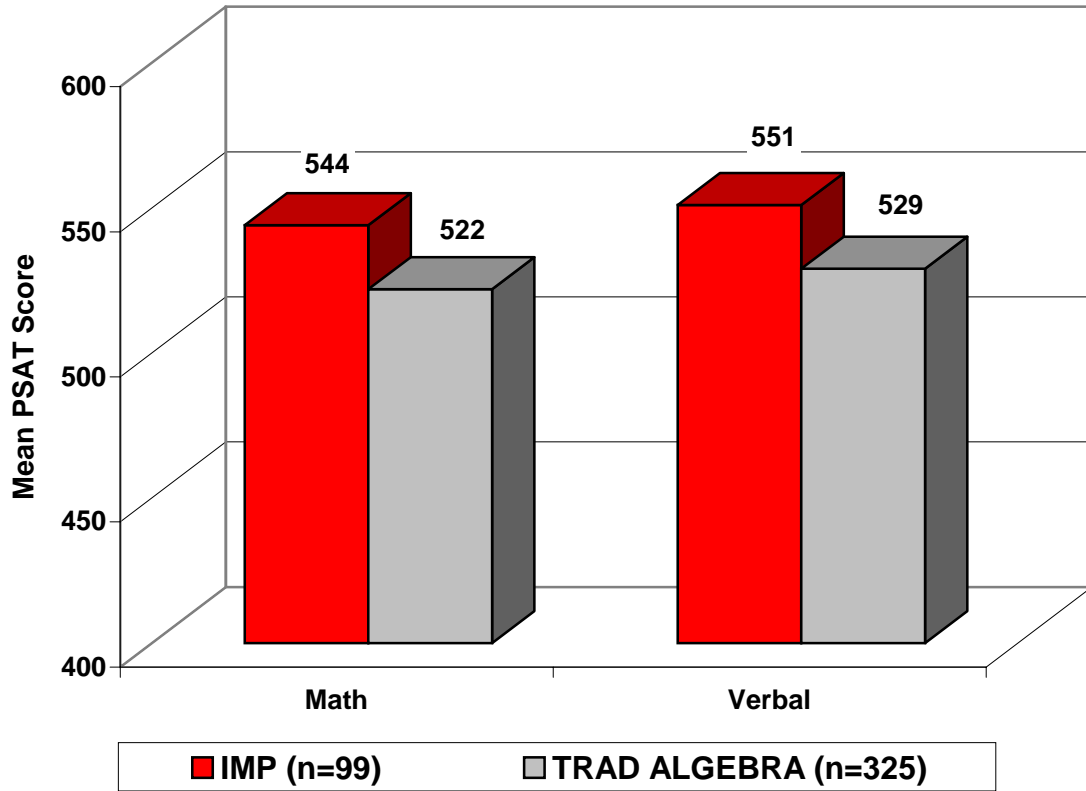
- 74 IMP2 10th grade students
- 350 Traditional math 10th grade students

October 1994  
10th Grade  
Analysis of PSAT Data  
Carver High School, Philadelphia



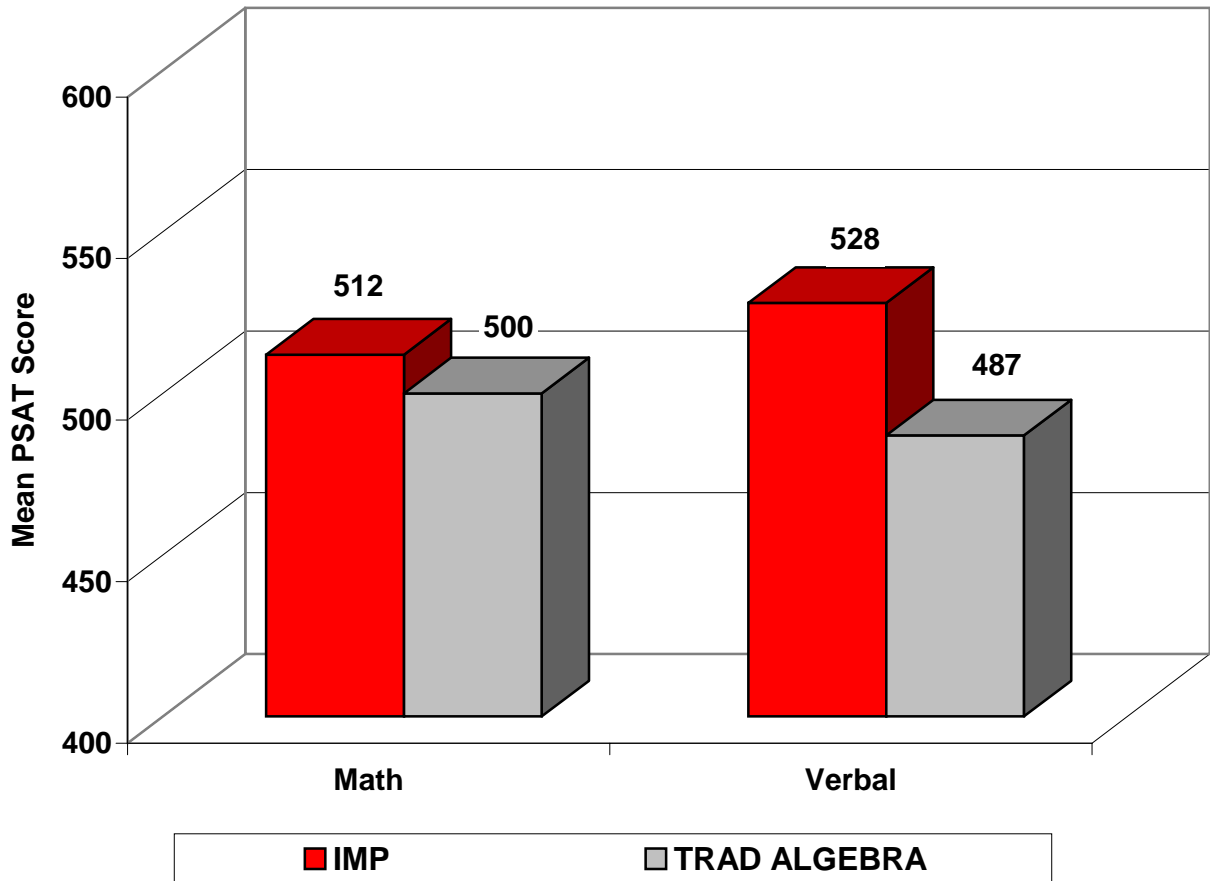
- Scores from the OCTOBER 1994 test administration of:
- 69 IMP2 10th grade students (this includes 11 IMP 1 students who did not take math in 9th grade)
  - 129 Traditional math 10th grade students

**Analysis of Central High School  
October 1995 PSAT Data  
for 11th Grade Students**

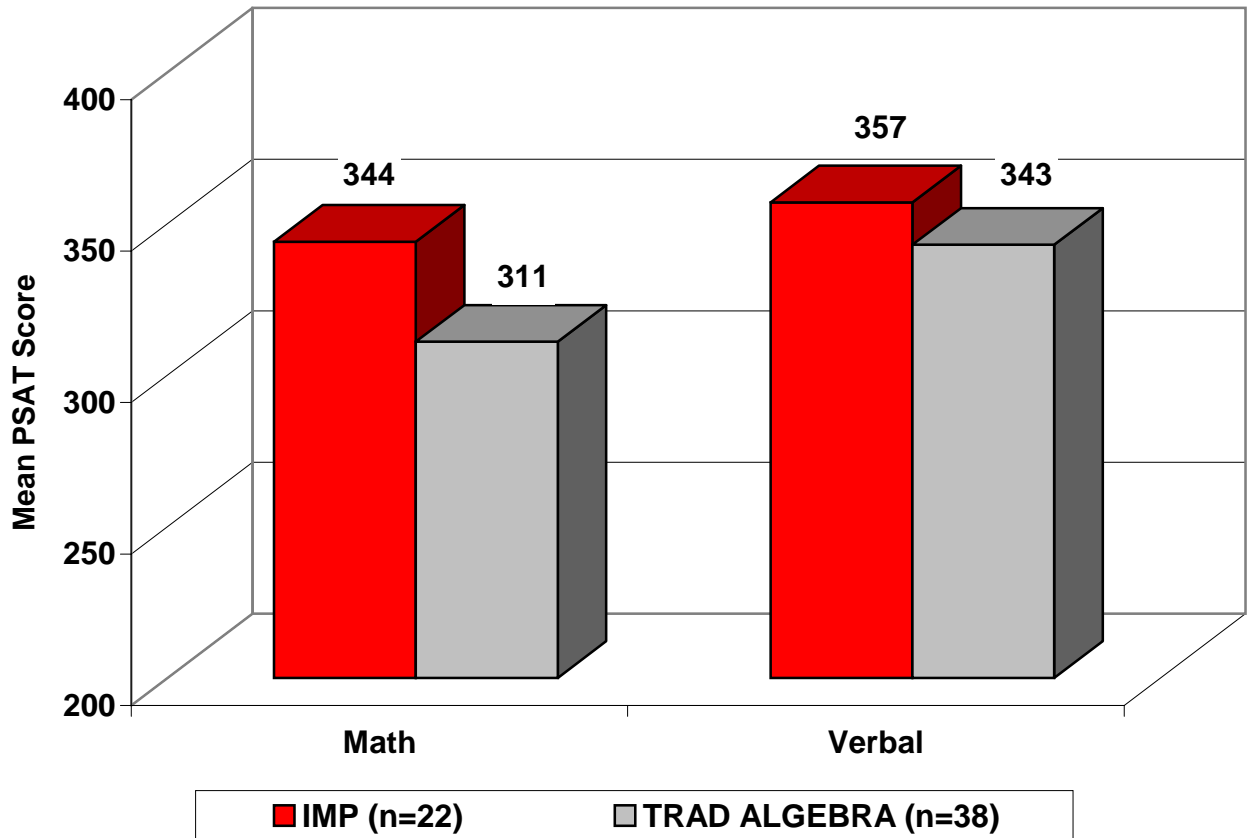


- Scores from the OCTOBER 1995 test administration of:
- 99 IMP3 11th grade students
  - 325 Traditional math 11th grade students

**Analysis of Carver High School  
October 1995 PSAT Data  
for 11th Grade Students**



**Analysis of Strawberry Mansion High School  
October 1995 PSAT Data  
for 11th Grade Students**



Scores from the OCTOBER 1995 test administration of:

- 22 IMP3 11th grade students
- 38 Traditional math 11th grade students

## **Later Philadelphia Data: 1997, 1998, 1999**

- Stanford Achievement Test – 9<sup>th</sup> Edition (SAT-9)
- Harvard Math Exit Test (an undergraduate degree requirement)

## HIGH SCHOOLS

### Performance Index (School Year 1997 – 1998)

**Academic Scores** (Derived from percentages of students at each performance level on the SAT-9)

SAT-9 Performance Level	Value	Reading		Mathematics		Science	
		% Students	Score	% Students	Score	% Students	Score
<b>Advanced</b>	1.2	1.3	1.6	0.8	1.0	0.1	0.1
Proficient	1.0	7.2	7.2	5.2	5.2	1.5	1.5
Basic	0.8	25.6	20.5	10.5	8.4	7.0	5.6
Below Basic III	0.6	20.7	12.4	22.3	13.4	20.0	12.0
Below Basic II	0.4	14.6	5.8	25.1	10.0	29.7	11.9
Below Basic I	0.2	10.7	2.1	9.8	2.0	14.1	2.8
Not Tested	0.0	19.8	0.0	26.2	0.0	27.5	0.0
Total Scores			<b>49.9</b>		<b>40.0</b>		<b>33.9</b>

Persistence		
Performance Level	%	Score
Advanced (96-100%)		
Proficient (95%)		
Basic (85-94%)		
Below Basic III (70-84%)		
Below Basic II (60-69%)	52.2	52.2
Below Basic I (50-59%)		
Unsatisfactory (0-49%)		
Total Score		<b>52.2</b>

### Enabling Scores

Performance Level (% Days Present)	Student Attendance		
	Value	% Students	Score
Advanced (96-100%)	1.2	19.5	23.4
Proficient (95%)	1.0	4.5	4.5
Basic (85-94%)	0.8	28.6	22.9
Below Basic III (80-84%)	0.6	8.2	4.9
Below Basic II (75-79%)	0.4	6.3	2.5
Below Basic I (10-74%)	0.2	29.2	5.8
Non-Attendees (0-9%)	0.0	3.7	0.0
Total Score			<b>64.0</b>

Performance Level (% Attended)	Staff Attendance		
	Value	% Staff	Score
Advanced (96-100%)	1.2	56.3	67.6
Proficient (95%)	1.0	11.4	11.4
Basic (93-94%)	0.8	12.0	9.6
Below Basic III (91-92%)	0.6	7.5	4.5
Below Basic II (89-90%)	0.0	2.7	0.0
Below Basic I (85-88%)	0.0	3.0	0.0
Low Attendees (1-84%)	0.0	7.1	0.0
Total Score			<b>93.1</b>

**Performance Target**

Index

<b>2</b>	Total Growth Needed Over 12 Years	<b>54.2</b>
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**Part One  
CYCLE 1**

**(1996-97 to 1997-98)**

(Student Attendance +  
Staff Attendance) / 2  
(Total Index Scores) / 5

1

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<b>Reading</b>	<b>49.6</b>
<b>Mathematics</b>	<b>40.0</b>
<b>Science</b>	<b>33.9</b>
<b>Persistence</b>	<b>52.2</b>
<b>Enabling</b>	<b>78.6</b>
<b>1998 Total</b>	<b>50.9</b>

1996 Baseline <b>Total</b>	<b>40.8</b>
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<b>3</b>	<b>Performance Target for Cycle 1 (Baseline + Growth Target)</b>	<b>49.8</b>
<b>4</b>	<b>Growth Target for Cycle 1 (Total Growth / 6)</b>	<b>9.0</b>
<b>5</b>	<b>Growth Achieved for Cycle 1 (1998 Total – Baseline Total)</b>	<b>10.1</b>
<b>6</b>	<b>Growth NOT Achieved for Cycle 1 (Growth Target – Growth Achieved)</b>	<b>*</b>

\* Not applicable because the school's 1997 – 1998 index score has exceeded the school's two-year target.

**School District of Philadelphia “Comparison of Spring 1996, 1997, 1998”  
Numbers (N) and Percentages (%) of Students at Each Performance Level**

Grade 4

<b>Reading</b>								
Level	1996		1997		1998		Change 96 to 98	
	N	%	N	%	N	%	N	%
<b>Advanced</b>	339	2.0	507	3.0	686	4.0	374	2.0
<b>Proficient</b>	1928	11.2	2411	14.2	2952	17.0	1024	5.8
<b>Basic</b>	5211	30.3	5807	34.1	6226	35.9	1015	5.6
<b>Below Basic III</b>	3579	20.8	3587	21.1	3406	19.7	-173	-1.1
<b>Below Basic II</b>	2400	14.0	2290	13.4	1957	11.3	-443	-2.7
<b>Below Basic I</b>	1198	7.0	1085	6.4	907	5.2	-291	-1.8
<b>Not Tested</b>	2547	14.8	1350	7.9	1194	6.9	-1353	-7.9
<b>Enrollment</b>	17202		17037		17328			

<b>Mathematics</b>								
Level	1996		1997		1998		Change 96 to 98	
	N	%	N	%	N	%	N	%
<b>Advanced</b>	262	1.5	459	2.7	562	3.2	300	1.7
<b>Proficient</b>	1255	7.3	1762	10.3	2042	11.8	787	4.5
<b>Basic</b>	448	26.1	5356	31.4	5664	32.7	1176	6.6
<b>Below Basic III</b>	4066	23.6	4118	24.2	4000	23.1	-66	-0.5
<b>Below Basic II</b>	3382	19.7	3051	17.9	3083	17.8	-299	-1.9
<b>Below Basic I</b>	925	5.4	894	5.2	831	4.8	-94	-0.6
<b>Not Tested</b>	2824	16.4	1397	8.2	1146	6.6	-1678	-9.8
<b>Enrollment</b>	17202		17037		17328			

Grade 8

<b>Reading</b>								
Level	1996		1997		1998		Change 96 to 98	
	N	%	N	%	N	%	N	%
<b>Advanced</b>	299	2.0	346	2.4	484	3.4	185	1.4
<b>Proficient</b>	2159	14.7	2516	17.2	2691	18.9	532	4.2
<b>Basic</b>	4711	32.0	5165	35.4	5306	37.3	595	5.3
<b>Below Basic III</b>	2262	15.4	2435	16.7	2473	17.4	211	2.0
<b>Below Basic II</b>	1313	8.9	1573	10.8	1302	9.1	-11	0.2
<b>Below Basic I</b>	568	3.9	878	6.0	674	4.7	106	0.8
<b>Not Tested</b>	3421	23.2	1687	11.6	1304	9.2	-2117	-14.0
<b>Enrollment</b>	14733		14600		14234			

<b>Mathematics</b>								
Level	1996		1997		1998		Change 96 to 98	
	N	%	N	%	N	%	N	%
<b>Advanced</b>	86	0.6	107	0.7	158	1.1	72	0.5
<b>Proficient</b>	746	5.1	825	5.7	1179	8.3	433	3.2
<b>Basic</b>	2276	15.4	2648	18.1	3155	22.2	879	6.8
<b>Below Basic III</b>	3698	25.1	3904	26.7	4232	29.7	534	4.6
<b>Below Basic II</b>	3080	20.9	3759	25.7	3283	23.1	203	2.2
<b>Below Basic I</b>	482	3.3	724	5.0	452	3.2	-30	-0.1
<b>Not Tested</b>	4365	29.6	2633	18.0	1775	12.5	-2590	-17.1
<b>Enrollment</b>	14733		14600		14234			

Grade 11

<b>Reading</b>								
Level	1996		1997		1998		Change 96 to 98	
	N	%	N	%	N	%	N	%
<b>Advanced</b>	106	0.9	112	1.0	146	1.3	40	0.4
<b>Proficient</b>	631	5.5	870	7.7	790	7.2	159	1.7
<b>Basic</b>	2236	19.5	2966	26.2	2799	25.6	563	6.1
<b>Below Basic III</b>	1695	14.8	21901	19.3	2262	20.7	567	5.9
<b>Below Basic II</b>	1127	9.8	1564	13.8	1595	14.6	468	4.8
<b>Below Basic I</b>	806	7.0	1214	10.7	1170	10.7	364	3.7
<b>Not Tested</b>	4858	42.4	2426	21.4	2167	19.8	-2691	-22.6
<b>Enrollment</b>	11459		11342		10929			

<b>Mathematics</b>								
Level	1996		1997		1998		Change 96 to 98	
	N	%	N	%	N	%	N	%
<b>Advanced</b>	58	0.5	55	0.5	87	0.8	29	0.3
<b>Proficient</b>	504	4.4	587	5.2	570	5.2	66	0.8
<b>Basic</b>	818	7.1	1031	9.1	1153	10.5	335	3.4
<b>Below Basic III</b>	1579	13.8	2161	19.1	2439	22.3	860	8.5
<b>Below Basic II</b>	1948	17.0	2865	25.3	2742	25.1	794	8.1
<b>Below Basic I</b>	839	7.3	1219	10.7	1072	9.8	233	2.5
<b>Not Tested</b>	5713	49.9	3424	30.2	2866	26.2	-2847	-23.7
<b>Enrollment</b>	11459		11342		10929			

**TEST DATE: MARCH, 1996**  
**Summary of a Matched-Sample Study Comparing**  
**IMP and Traditionally-Taught Students on**  
**the Stanford Achievement Test-9th Edition at**  
**Central High School, Philadelphia Pa**

**Introduction:** In a carefully controlled matched-sample study, the performance of 83 students in the Interactive Mathematics Program (IMP) and 83 traditionally-taught algebra students were compared using the Stanford Achievement Test (SAT-9) which was administered in March 1996. All students in the study were enrolled in their third mathematics course at Central High School as of 1995-96, their junior year.

The 83 **IMP** students represented all students enrolled in IMP Level 3 classes during the 1995-96 academic year for whom complete data was available. The 83 traditional students were chosen so that they matched the IMP students with regard to 1) gender, 2) number of students attending public and private schools in eighth grade, and 3) percentile scores on national, standardized tests taken by the students in eighth grade.

**Description of Samples:**

Total Sample Size	83	83
Males	41	41
Females	42	42
Public School (8th grade)	33	33
Private School (8th grade)	50	50
8th grade national percentiles		
Math	95.9	95.9
Verbal	95.8	95.8

Results: **IMP** *outperformed* traditional students in **21** out of 28 reported SAT-9 multiple choice categories. Of these, the Probability and Functions gain scores are statistically significant. There were 3 categories where **IMP** and traditional students tied. There were 4 categories where the traditional scores were higher than IMP. Of these, none are statistically significant.

*The IMP students' scores on the following Stanford-9 Multiple Choice sub-scores were higher than those of their traditional counterparts:*

	<b>IMP</b>	
Traditional		
<b>Mathematics Content Cluster Total</b>	<b>33.9</b>	<b>32.2</b>
Problem-Solving Strategies	2.3	2.1
Statistics	4.8	4.6
Probability	3.9	3.0
Functions	4.1	3.7
Geometry from an Algebra Perspective	3.5	3.1
Discrete Mathematics	2.1	2.0
<b>Mathematics Process Cluster Total</b>	<b>33.9</b>	<b>32.2</b>
Mathematics as Problem Solving	10.6	10.0
Mathematics as Reasoning	10.7	9.9
Mathematics as Communication	5.5	5.4
<u>Mathematics as Connections</u>	<u>7.0</u>	<u>6.7</u>
Thinking Skills	23.2	21.7
<b>Reading Comprehension Content Cluster Total</b>	<b>45.8</b>	<b>44.5</b>
Recreational Reading Comprehension	16.3	15.6
Textual Reading Comprehension	15.5	15.0
Functional Reading Comprehension	14.0	13.8
<b>Reading Comprehension Process Total</b>	<b>45.8</b>	<b>44.5</b>
Initial Understanding	8.7	8.4
Interpretation	21.0	20.1
<u>Process Strategies</u>	<u>8.0</u>	<u>7.9</u>
Thinking Skills	37.1	36.0
<b>Science Process Cluster Total</b>	<b>23.7</b>	<b>23.2</b>
Using Evidence Models	13.9	13.5
Patterns of Change	6.0	5.7
Thinking Skills	18.1	17.5

*Both groups of students tied on the following sub-scores:*

	<b>IMP</b>	
Traditional		
Conceptual Underpinnings of Calculus	1.4	1.4
Trigonometry	2.3	2.3
Reading: Critical Analysis	8.1	8.1

*The traditional students outscored the IMP students on the following sub-scores:*

	<b>IMP</b>	
Traditional		
Algebra	5.0	5.2
Geometry from a Synthetic Perspective	4.6	4.7
Trigonometry	2.3	2.4
Science: Comparing Form and Functions	3.8	4.0
<b>Open-ended Assessments:</b>		
Math Score	22.3	22.0
Reading Score	22.0	21.5

**Description of Stanford-9 Test:** The Stanford Achievement Test - 9th Edition (SAT-9) reflects national content area standards in Reading, Mathematics and Science. It assesses higher-order thinking skills by integrating process with knowledge. The SAT-9 often requires the student to write an answer not simply recall facts.

The SAT-9 test scores are reported in three components: 1) multiple choice, 2) open-ended assessment, and 3) a composite score. Scores for each of the three components are reflected in Reading, Mathematics and Science.

**Research Notes:**

- 1) The current study reflects students who had approximately 2 1/2 years of IMP. Differences in student performance after 4 years of IMP should be investigated.
- 2) Two of the traditional students were absent on the day that the open-ended science portion of the exam was given. Therefore, this study did not analyze the open-ended science and composite science scores. For future versions of this report, we will replace those students with two similar students (based on eighth grade result, gender, and type of school attended) and will include all science process-related sub-scores.
- 3) Individuals seeking more information regarding this study should contact:

Dr. Edward (Ned) Wolff  
Department of Mathematics Beaver College  
450 S. Easton Road  
Glenside, PA 19038  
Phone: 215-572-2984  
e-mail: wolff@beaver.edu

April 10, 1997

**TEST DATE: MARCH, 1996**  
**Summary of Matched-Sample Analysis**  
**Comparing IMP and Traditionally-Taught Students on the**  
**Mathematics Portion of the Stanford-9 Test at the**  
**Philadelphia Hi2b School For Girls**

**Introduction:** In a matched-sample study conducted by Dr. Edward Wolff and Patricia Decktor, performance of 55 **IMP** students and 55 traditionally-taught students were compared on mathematics subscores of the Stanford Achievement Test, 9th edition.

The IMP students represented all students enrolled in IMP Level 3 classes during the 1995-96 academic year, excluding only a few students for whom complete data was not available. The 55 traditionally-taught students were chosen so that they matched the IMP students with regard to percentile scores on previously taken eighth grade national, standardized tests.

All students in the study were enrolled in their third mathematics course at Girls' High as of the Spring of 1996. Thus, the IMP students studied had been exposed to approximately 2 1/2 years of a standards-based curriculum (EMP) and student-centered teaching methods.

**Description of Samples:**

	<b>IMP</b>	Traditional
Total Sample Size	<b>55</b>	<b>55</b>
Males	0	0
Females	55	55
8th grade mean math normal curve equivalency (z-score)	.806	.803
corresponding national percentile	<b>79.0</b>	<b>78.9</b>
8th grade mean verbal normal curve equivalency (z-score)	.681	.697
corresponding national percentile	<b>75.2</b>	<b>75.7</b>

March 1996 Girls High Study

**Results:** The overall summary score reported by the Stanford-9 is the "Mathematics Proficiency Level." More EMP students achieved "Basic" proficiency and less "Below Basic" than traditionally- taught students.

The distribution of proficiency level scores is as follows:

	Number & Percent of Students	
	IMP	Traditional
Level 3 (Advanced)	0 (0.0%)	0 ( 0.0%)
Level 2 (Proficient)	16 (29.1%)	16 (29.1%)
<b>Level I (Basic)</b>	<b>23 (41.8%)</b>	<b>15 (27.3%)</b>
Level 0 (Below Basic)	16 (29.1%)	24 (43.6%)

Of the 17 math-related scores of the SAT-9, EMP students *outperformed* their traditionally taught counterparts on 12, tied on two and scored slightly lower on three. **IMP** students did better on all the cumulative scores and the open-ended assessments.

*The IMP-3 students' scores on the following Stanford 9 subscores were higher than those of their traditional counterparts:*

	IMP	Traditional
<b>Mathematics Content Cluster Total</b>	<b>29.6</b>	<b>28.5</b>
Statistics	4.5	4.3
Probability	2.9	2.3
Functions	3.7	3.3
Geometry from Synthetic Perspective	4.2	4.0
Geometry from an Algebra Perspective	2.8	2.7
Discrete Mathematics	1.8	1.6
<b>Mathematics Process Cluster Total</b>	<b>29.6</b>	<b>28.5</b>
Mathematics as Problem Solving	9.2	8.5
Mathematics as Reasoning	9.3	9.1
Mathematics as Communication	4.8	4.7
<b>Thinking Skills</b>	<b>20.0</b>	<b>19.4</b>
<b>Mathematics Open-Ended Raw Score</b>	<b>21.3</b>	<b>19.5</b>
<b>Comprehensive Raw Score</b>	<b>50.9</b>	<b>46.7</b>
<b>Overall Mathematics Proficiency Level</b>	<b>1.00</b>	<b>.86</b>

*Both groups of students tied on the following subscores:*

	<b>IMP</b>	Traditional
Problem Solving Strat	1.9	1.9
Making Connections	6.3	6.3

*The traditional students outscored the IMP students on the following Stanford subscores:*

	<b>IMP</b>	Traditional
Algebra	4.8	4.9
Trigonometry	2.1	2.3
Underpinnings of Calculus	1.0	1.2

Discussion: The Interactive Mathematics Program (IMP) was created in the late 1980's to implement the NCTM Standards. The Standards call for the reform of the traditional topic-based mathematics curricula to better prepare students for the intellectual demands of the 21st century.

Specifically, the NCTM Standards call for increased emphasis on problem solving, communication skills, probability, statistics, and discrete mathematics, which currently receive minimal coverage in traditional mathematics texts.

Critics of IMP and other standards-based reform curricula and teaching methods often charge that students are not trained to be as facile as traditional students in algebraic symbol manipulation. While the above results show that traditionally-taught students did slightly better than the IMP students in this area, this study also shows that the IMP curriculum is considerably more effective than the traditional in preparing students to succeed in those areas deemed most important by today's leading mathematics educators--thinking, reasoning and non-routine problem solving.

Individuals seeking more information regarding this study should contact:

Dr. Edward (Ned) Wolff  
Dept. of Mathematics Beaver College  
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Glenside, PA 19038

Phone: 215-572-2984  
E-mail: wolff@beaver.edu

September 24, 1997

## Test date: Spring 1997

### SAT-9 Analysis Matched Sample Analyses At Magnet and Comprehensive Schools

Analyzed by  
Ned Wolff on 6/14/98 using Minitab Statistical Software

Note: Math scores were from multiple choice portion of SAT-9 test reported on the I - 6 scale used by School District of Philadelphia. (4 is basic, 5 proficient, and 6 advanced)

#### Magnet Schools:

Sample consisted of 96 IMP and 96 traditionally taught students, matched by eighth grade CTBS scores.

	IMP	Traditional
Mean CTBS (8th grade)	813.8	814.2
Mean SAT-9 (11th grade)	4.53	4.26

(P = .084)

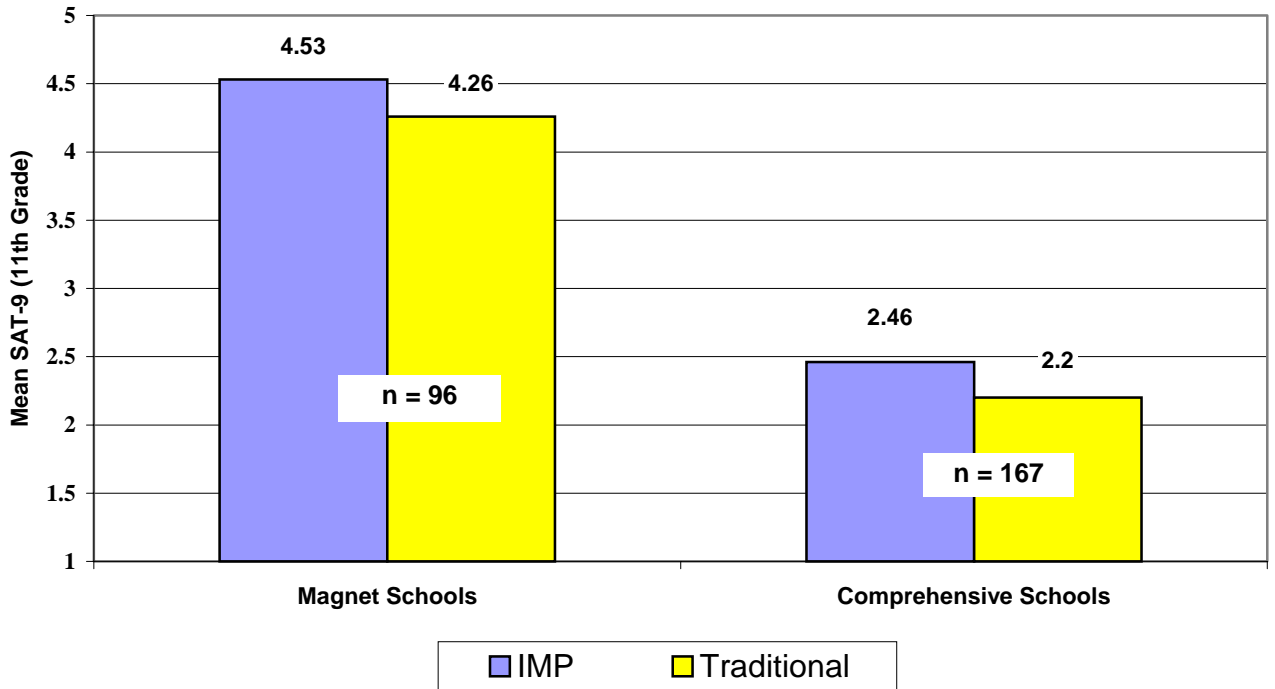
#### Comprehensive Schools:

Sample consisted of 167 IMP and 167 traditionally taught students, matched by eighth grade CTBS scores.

	IMP	Traditional
Mean CTBS (8th grade)	752.8	753.4
Mean SAT-9 (11th grade)	2.46	2.20

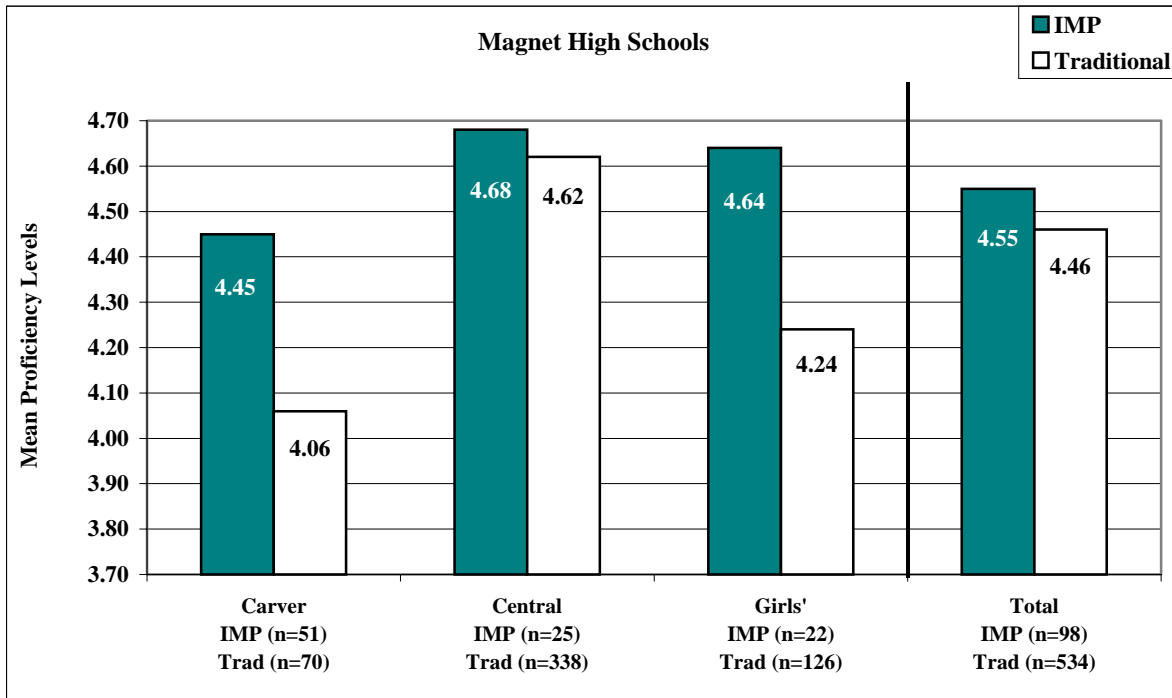
(P = .020)

**SAT-9 Analysis Matched Sample Analyses  
At Magnet and Comprehensive Schools  
Test Date: Spring 1997**

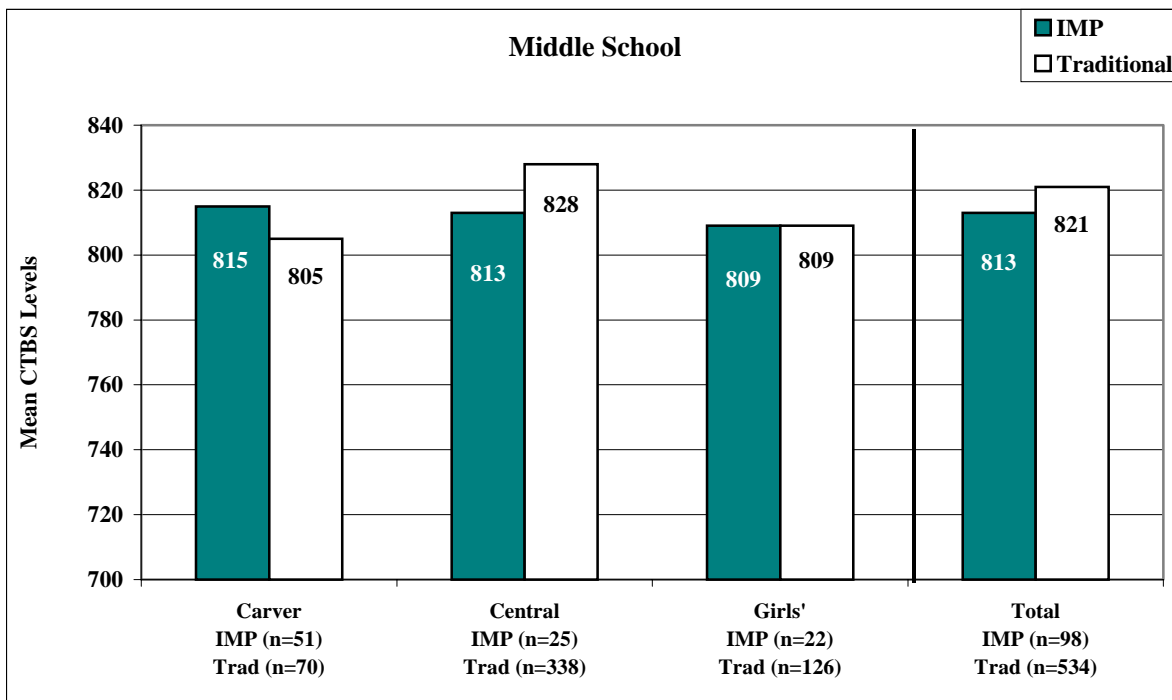


Math scores were from multiple choice portion of SAT-9 test reported on the 1 - 6 scale used by School District of Philadelphia (4 is basic, 5 proficient, and 6 advanced).

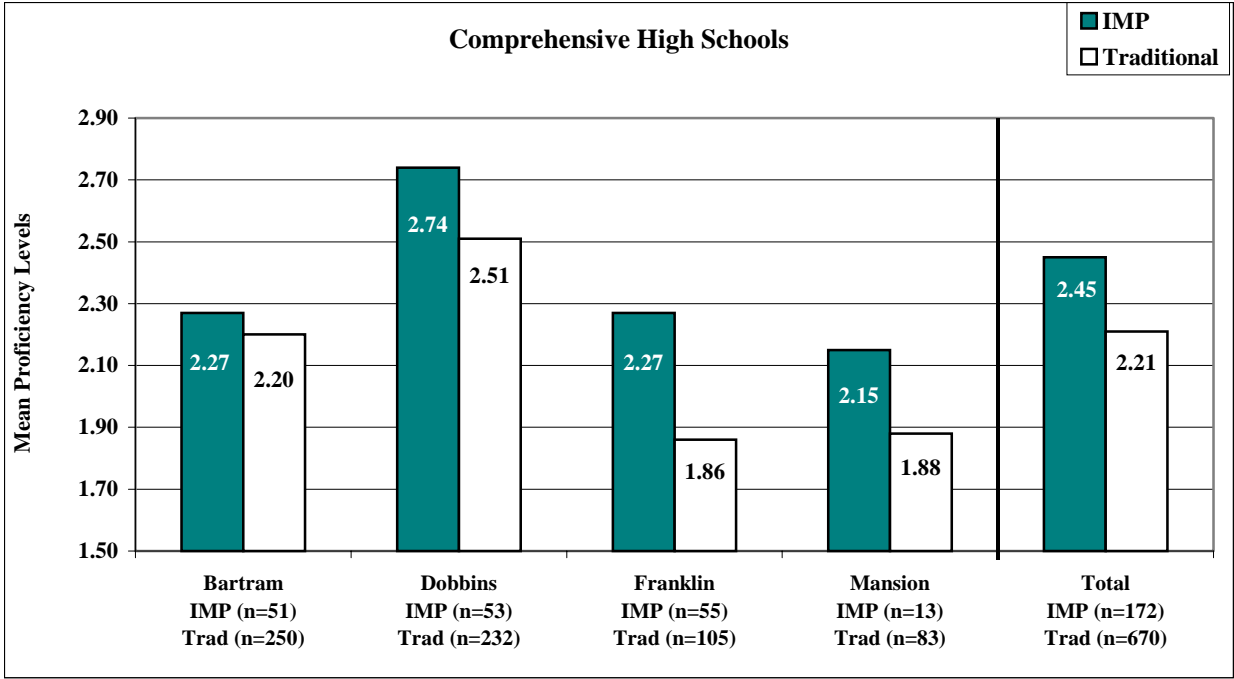
**Summary of 11<sup>th</sup> Grade Students' SAT-9 Results  
April, 1997  
Math Proficiency Scores**



**Summary of 8<sup>th</sup> grade CTBS Results  
Of the Same Students**



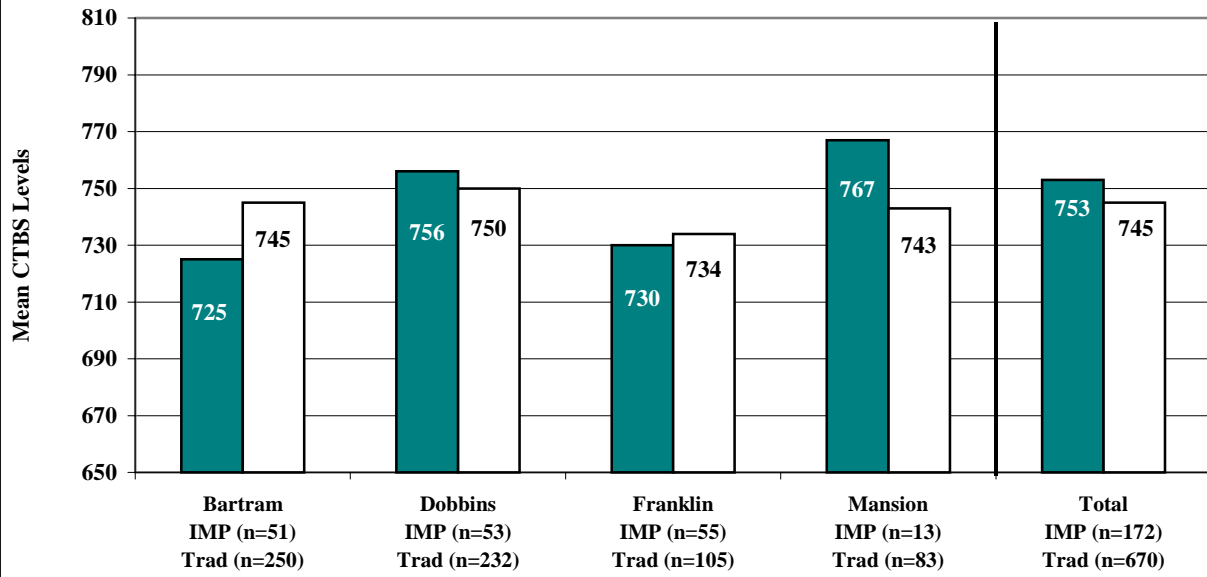
**Summary of 11<sup>th</sup> Grade Students' SAT-9 Results  
April, 1997  
Math Proficiency Scores**



**Summary of 8<sup>th</sup> grade CTBS Results  
Of the Same Students**

### Middle School

■ IMP  
□ Traditional

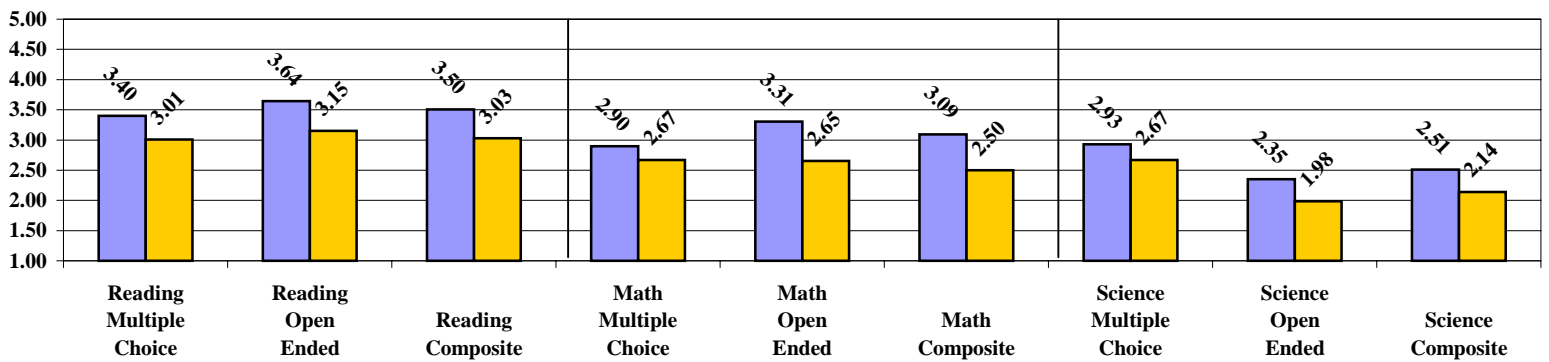


# 1998 SAT 9 Charts

CHART 1-A

Average Stanford 9 Achievement Test Scores for  
 All 10 Philadelphia IMP Schools  
 IMP vs TRAD  
 All 11th Grade Students Included  
 Advanced, SPED, MG, ESOL and \* Students Included  
 Test Date: April 1998

■ IMP Scores (n=407)  
 ■ TRAD Scores (n=2200)



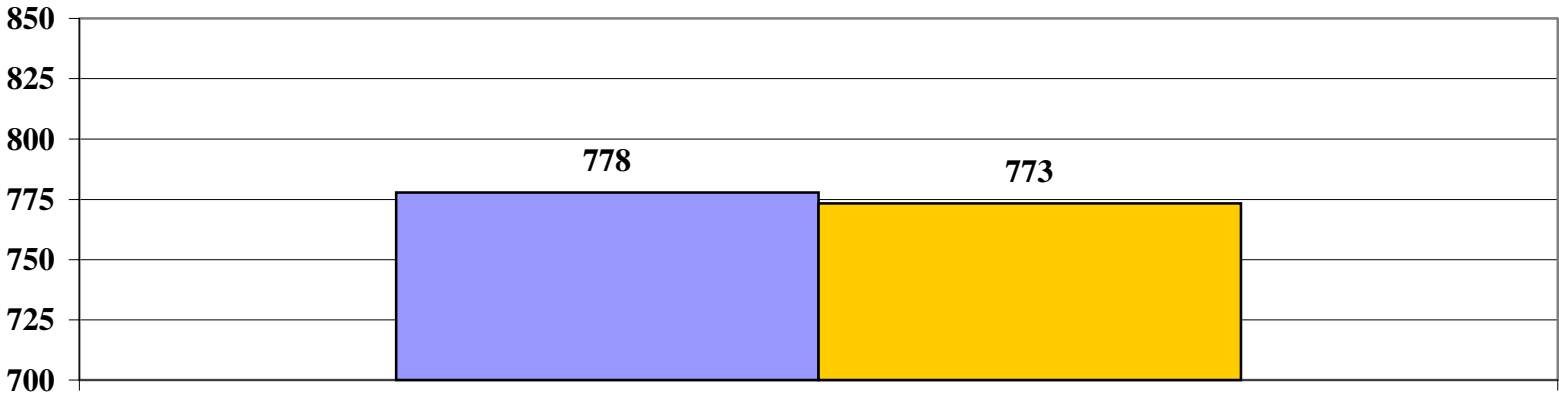
This chart represents the average Stanford 9 Achievement Test (SAT-9) scores for all 10 Philadelphia IMP schools who took the SAT-9s. The students in this analysis were 11th graders during the 1997-1998 school year. Included in the analysis are all IMP and traditionally taught students, including ESOL, SPED, MG and \* students (students who did not take at least one section of the test). Also included are Advanced Traditional Students who have taken 1 or 2 extra math courses.

**CHART 1-B**

**Average CTBS Scores for  
All 10 Philadelphia IMP Schools  
IMP vs TRAD**

■ IMP Students (n=232)  
■ TRAD Students (n=1018)

**Only 11th Grade Students with CTBS Scores Included  
Advanced, SPED, MG, ESOL and \* Students Included  
Test Date: April 1998**



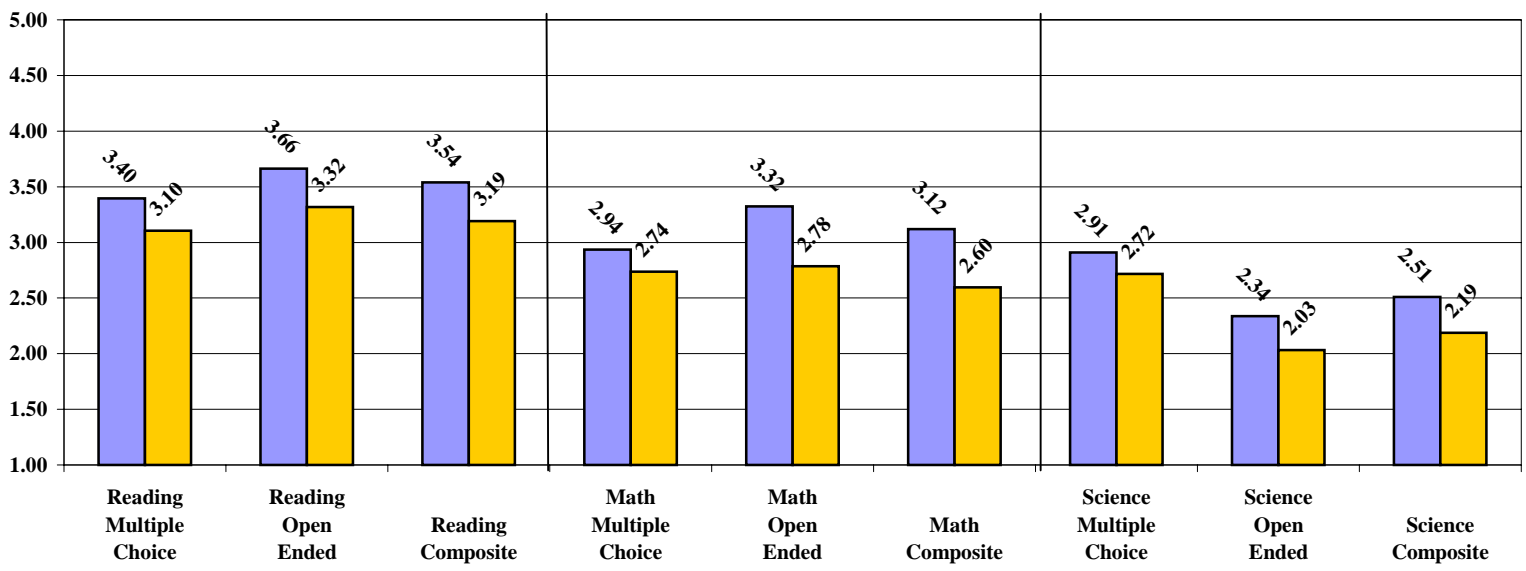
**Average CTBS Scores**

This chart represents the average 8th Grade CTBS scores for all 10 Philadelphia IMP schools and students who participated in the Stanford 9 Achievement tests and who have CTBS scores on record. The students in this survey were 11th graders during the 1997-1998 school year. Included in the analysis are all IMP and traditionally taught students, including ESOL, SPED, MG and \* students (students who did not take at least one section of the SAT-9 test). Also included are Advanced

**CHART 1-C**

**Average Stanford 9 Achievement Test Scores for  
All 10 Philadelphia IMP Schools  
IMP vs TRAD  
Only 11th Grade Students with CTBS Scores Included  
Advanced, SPED, MG, ESOL, and \* Students Included  
Test Date: April 1998**

**IMP Scores (n=232)**  
**TRAD Scores (n=1018)**

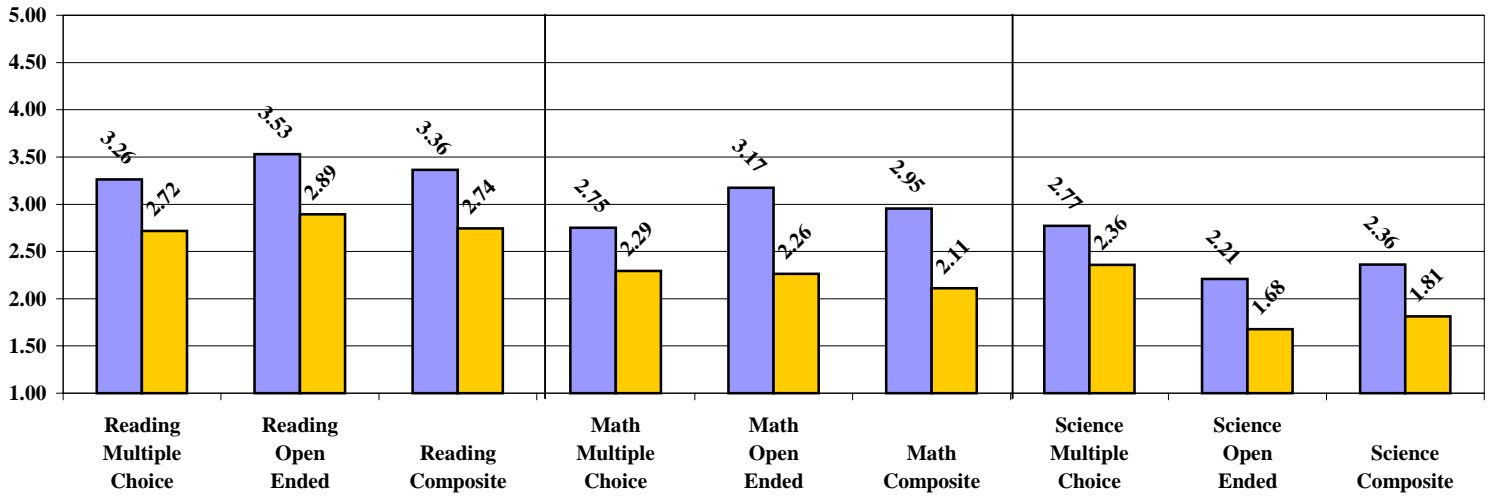


This chart represents the average Stanford 9 Achievement Test (SAT-9) scores for all 10 Philadelphia IMP schools. The students in this survey were 11th graders during the 1997-1998 school year and also had 8th Grade CTBS Scores. Included in the survey are all students, including ESOL, SPED, MG and \* students (students who did not take at least one section of the SAT-9 test). Also included are Advanced Students who have taken 1 or 2 extra math courses.

**CHART 2-A**

**Average Stanford 9 Achievement Scores for  
All 10 Philadelphia IMP Schools  
IMP vs TRAD  
All 11th Grade Students Included  
Except for Advanced, SPED, MG, and ESOL Students  
Test Date: April 1998**

■ IMP Scores (n=355)  
■ TRAD Scores (n=1672)

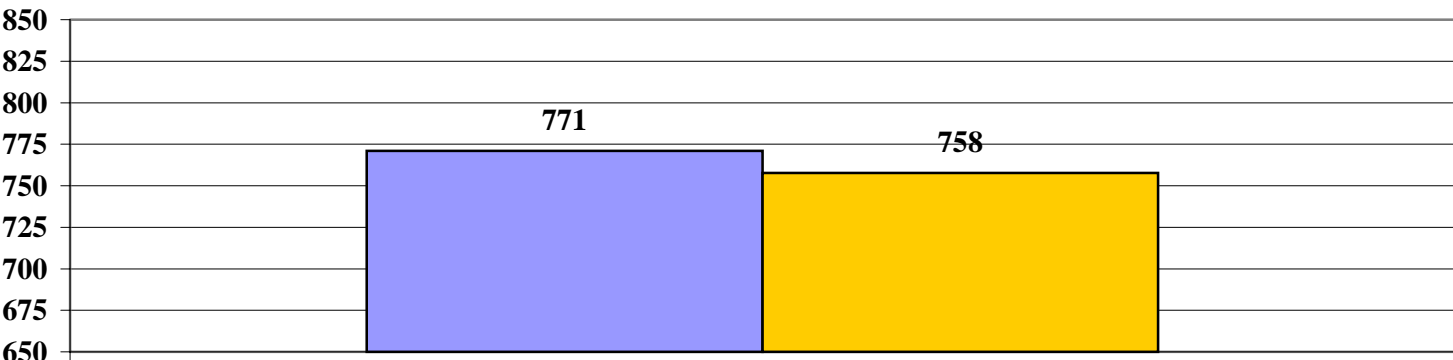


This chart represents the average Stanford 9 Achievement Test scores for all 10 Philadelphia IMP schools. The students in this analysis were 11th grade students during the 1997-1998 school year. Included in the analysis are all IMP and traditionally taught students. Excluded are ESOL, SPED, MG and Advanced Students (students who have taken 1 or 2 extra math courses).

**CHART 2-B**

**Average CTBS Scores for  
All 10 Philadelphia IMP Schools  
IMP vs TRAD  
All 11th Grade Students with CTBS Scores Included  
Except Advanced, SPED, MG, and ESOL Students  
Test Date: April 1998**

**■ IMP Students (n=194)**  
**■ TRAD Students (n=761)**



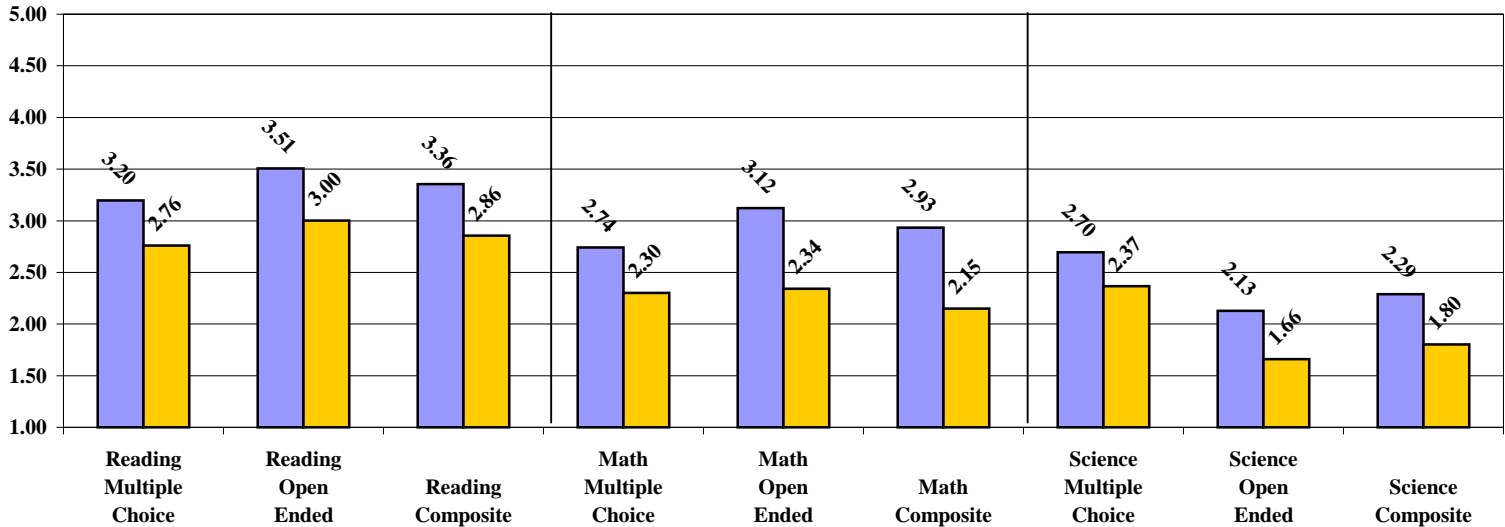
**Average CTBS Scores**

This chart represents the average 8th grade CTBS scores for all 10 Philadelphia IMP schools and students who participated in the Stanford 9 Achievement Tests and who have CTBS scores on record. The students in this analysis were 11th grade students during the 1997-1998 school year. Included in the analysis are all IMP and traditionally taught students. Excluded are ESOL, SPED, MG and Advanced Students (students who have taken 1 or 2 extra math courses).

CHART 2-C

Average Stanford 9 Scores for  
All 10 Philadelphia IMP Schools  
IMP vs TRAD  
All 11th Grade Students with CTBS Scores Included  
Except Advanced, SPED, MG, and ESOL Students  
Test Date: April 1998

■ IMP Scores (n=194)  
■ TRAD Scores (n=761)

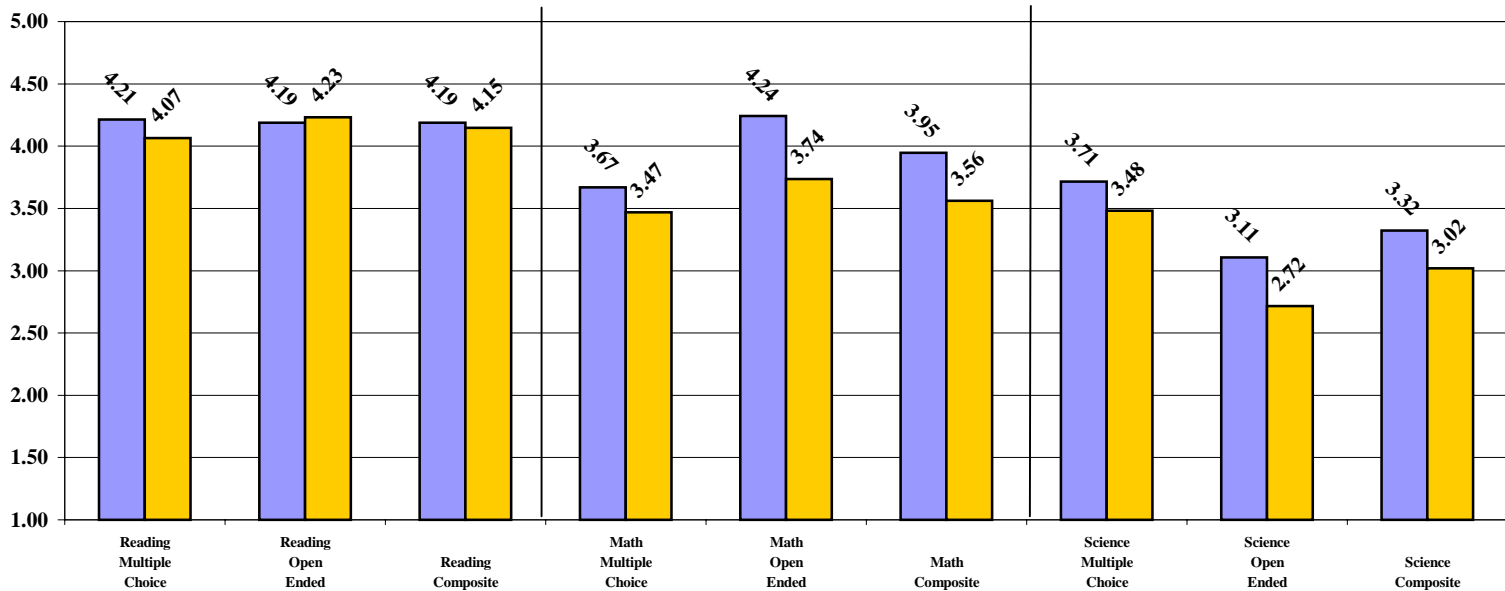


This chart represents the average Stanford 9 Achievement Test scores for all 10 Philadelphia IMP schools who also had 8th Grade CTBS Scores. The students in this analysis were 11th grade students during the 1997-1998 school year. Included in the analysis are all IMP and traditionally taught students. Excluded are ESOL, SPED, MG and Advanced Students (students who have taken 1 or 2 extra math courses).

CHART 3-A

Average Stanford 9 Scores for  
Carver, Central and Girls' High Schools  
IMP vs TRAD  
All Students Included  
Except MG, \*, ESOL and Advanced  
Test Date: April 1998

■ IMP Scores (n=112)  
■ TRAD Scores (n=430)

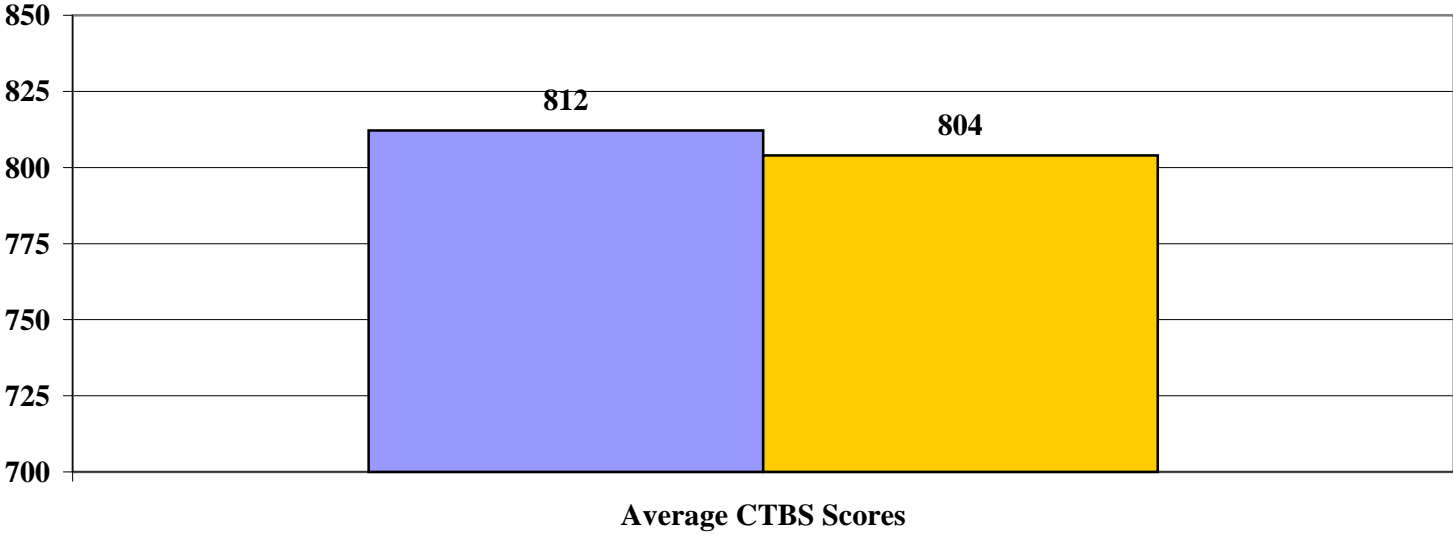


This chart represents the average Stanford 9 Achievement Test scores for Carver, Central and Girls' high schools. The students in this analysis were 11th grade students during the 1997-1998 school year. Included in the analysis are all IMP and traditionally taught students. Excluded are ESOL, SPED, MG and Advanced Students (students who have taken 1 or 2 extra math courses).

**CHART 3-B**

**Average CTBS Scores for  
Carver, Central and Girls' High Schools  
IMP vs TRAD  
All Students with CTBS Scores Included  
Except MG, ESOL, Advanced and \* Students  
Test Date: April 1998**

**■ IMP Students (n=56)**  
**■ TRAD Students (n=178)**

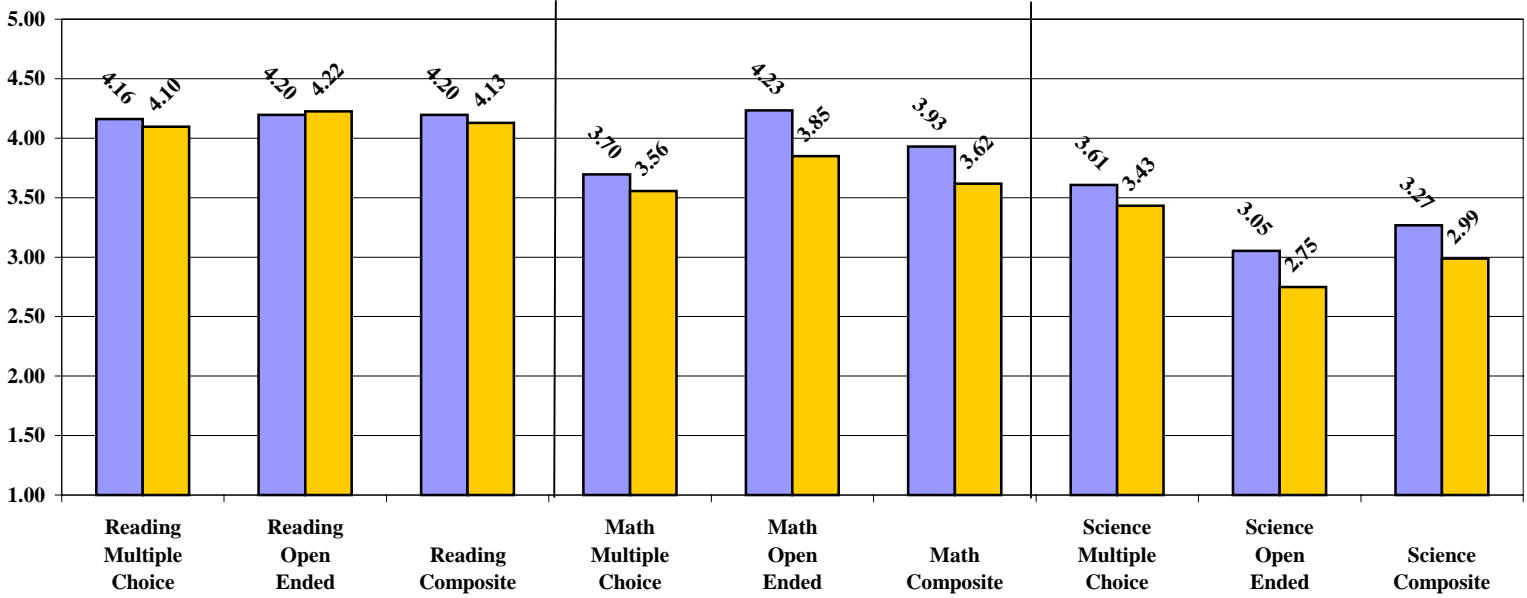


This chart represents the average 8th grade CTBS scores for Carver, Central and Girls' high schools and students who participated in the Stanford 9 Achievement Tests. The students in this analysis were 11th grade students during the 1997-1998 school year. Included in the analysis are all IMP and traditionally taught students. Excluded are ESOL, SPED, MG and Advanced Students (students who have taken 1 or 2 extra math courses).

CHART 3-C

Average Stanford 9 Scores for  
Carver, Central and Girls' High Schools  
IMP vs TRAD Algebra  
All Students with CTBS Scores Included  
Except MG, \*, ESOL and Advanced  
Test Date: April 1998

■ IMP Scores (n=56)  
■ TRAD Scores (n=178)

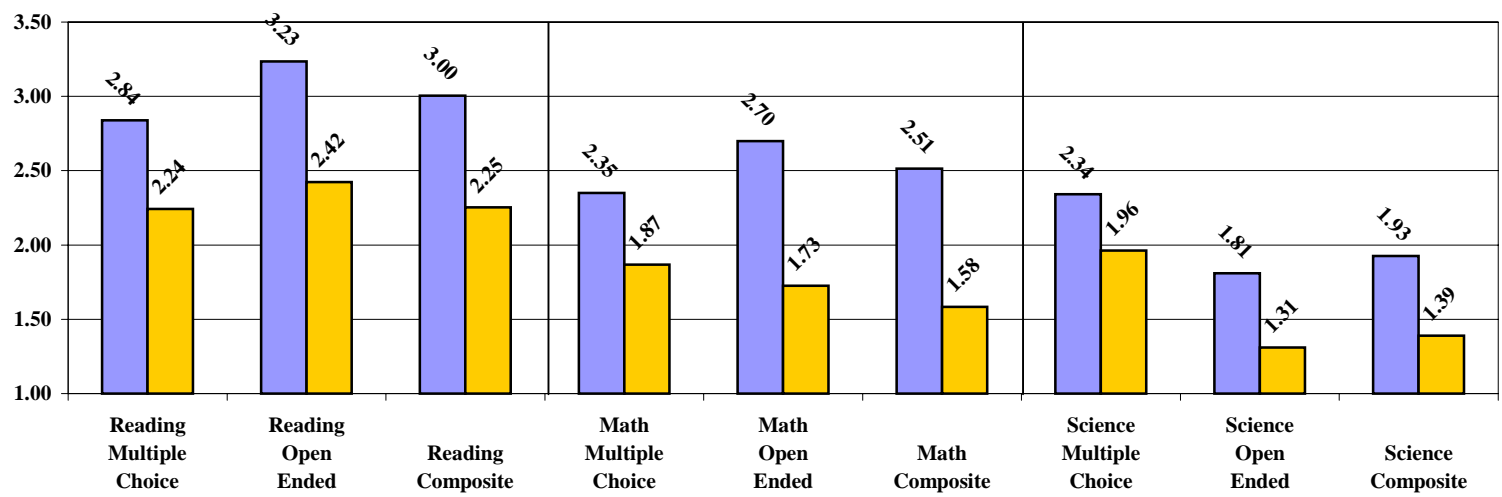


This chart represents the average Stanford 9 Achievement Test scores for Carver, Central and Girls' high schools and those students who also had 8th Grade CTBS scores. The students in this analysis were 11th grade students during the 1997-1998 school year. Included in the analysis are all IMP and traditionally taught students. Excluded are ESOL, SPED, MG and Advanced Students (students who have taken 1 or 2 extra math courses).

**CHART 4-A**

**Average Stanford 9 Scores for  
Philadelphia IMP Comprehensive Schools  
IMP vs TRAD  
All 11th Grade Students Included  
Except ESOL, SPED, MG and Advanced Students  
Test Date: April 1998**

■ IMP Scores (n=243)  
■ TRAD Scores (n=1212)

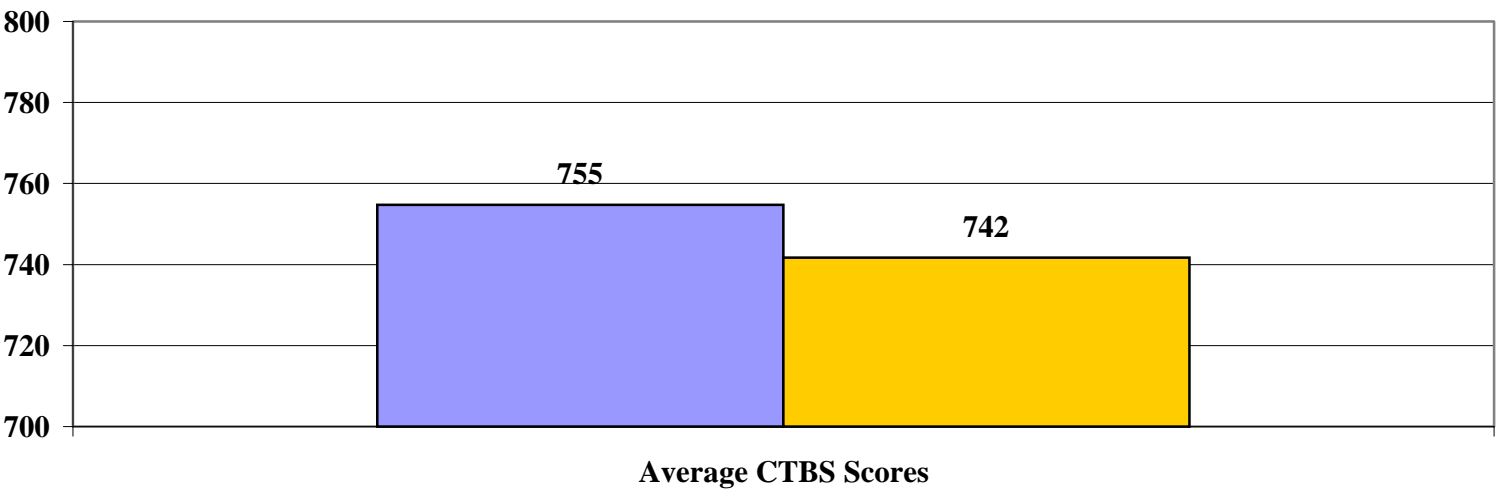


This chart represents the average Stanford 9 Achievement for Philadelphia Comprehensive high schools. The students in this analysis were 11th grade students during the 1997-1998 school year. Included in the analysis are all IMP and traditionally taught students. Excluded are ESOL, SPED, MG and Advanced Students (students who have taken 1 or 2 extra math courses).

**CHART 4-B**

**Average CTBS Scores for  
Philadelphia IMP Comprehensive Schools  
IMP vs TRAD  
All 11th Grade Students with CTBS Scores Included  
Except ESOL, SPED MG and Advanced Students  
Test Date: April 1998**

**■ IMP Students (n=138)**  
**■ TRAD Students (n=568)**



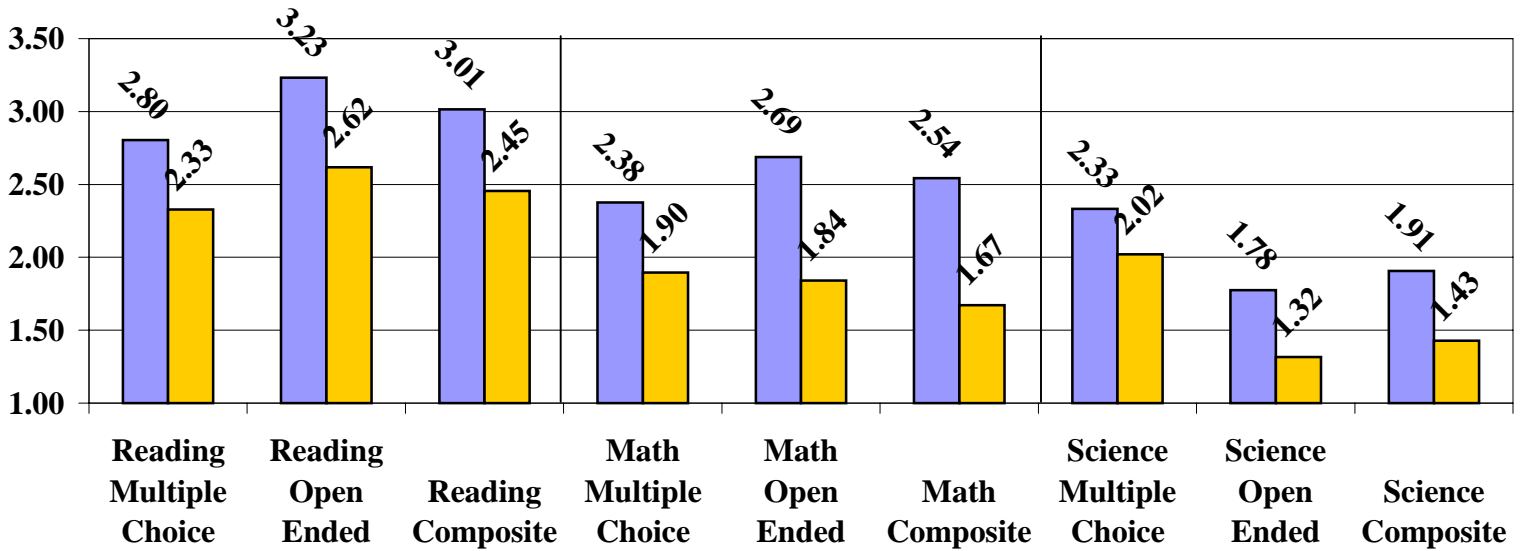
This chart represents the average 8th grade CTBS scores for All Philadelphia Comprehensive IMP schools and students who participated in the Stanford 9 Achievement Tests. The students in this analysis were 11th grade students during the 1997-1998 school year. Included in the analysis are all IMP and traditionally taught students. Excluded are ESOL, SPED, MG and Advanced Students (students who have taken 1 or 2 extra math courses).

CHART 4-C

Average Stanford 9 Achievement Test Scores for Philadelphia IMP Comprehensive Schools  
 IMP vs TRAD

All 11th Grade Students with CTBS Scores Included  
 Except ESOL, SPED, MG and Advanced Students  
 Test Date: April 1998

■ IMP Scores (n=138)  
 ■ TRAD Scores (n=568)



This chart represents the average Stanford 9 Achievement Test Scores for Philadelphia Comprehensive IMP high schools and those students who also had 8th Grade CTBS scores. The students in this analysis were 11th grade students during the 1997-1998 school year. Included in the analysis are all IMP and traditionally taught students. Excluded are ESOL, SPED, MG and Advanced Students (students who have taken 1 or 2 extra math courses).

## IMPressions Article

A recent analysis of SAT-9 math scores at Philadelphia's High School for Girls showed that IMP students outperformed their traditionally taught counterparts. The study was conducted by Dr. Ned Wolff of Beaver College with the support of Steven Kramer of the University of Maryland and Atenssa Cheek of La Salle University. Three different scores were examined: the composite mathematics score and its two major components, the open-ended and multiple choice scores. To account for differences in student backgrounds before enrolling in high school, the study took into consideration the students eighth grade test scores on the California Test of Basic Skills (CTBS). Using the statistical technique, Analysis of Covariance, it computed and compared the two lines (called regression lines) that best predict IMP and traditional students' eleventh grade SAT-9 scores from their eighth grade CTBS scores.

All students were included in the study as long as they did not switch math programs and the Philadelphia School District was able to supply both eleventh grade math SAT-9 scores and eighth grade math CTBS scores. The only exception was that one of the traditional students was dropped from the study. A so-called "outlier", this student did very well on eighth grade CTBS but so poorly on the SAT-9 that, if included in the study, would have appreciably lowered the overall performance of the traditional group. Remaining in the study were 27 IMP and 138 traditional students.

The graph above shows the regression lines for both the IMP and traditional students where the composite math SAT-9 scores are predicted from the CTBS scores. The fact that the IMP line is higher means that if an IMP student and traditional student had the same CTBS score, the IMP students generally got a higher SAT-9 score. The IMP gains demonstrated in this study were statistically significant ( $p < .01$ ).

The steeper slope of the IMP regression line suggests that IMP was especially beneficial for the best students, because the further to the right you go, the greater the gap between the predicted scores of IMP and traditional students. However, the difference in slopes of the two regression lines turned out not to be significant (perhaps due to the small number of IMP students). Therefore, the study next proceeded on the assumption that the lines were parallel. The equations of the best-fit *parallel* lines were consequently computed, and the vertical distance between these lines was found to be 9.73. That is, if an IMP and a traditional student both have the same eight-

grade CTBS math scores, the IMP student's predicted eleventh grade SAT-9 math composite score would be 9.73 points higher.

To better understand the gains demonstrated by IMP students, the open-ended and multiple-choice questions were examined separately. The graph above shows the best-fit lines for the open-ended component of the test. As suggested by the figure, IMP students significantly outscored ( $p < .01$ ) the traditional students on this portion of the test by a comparatively large margin.

Indeed, given the same CTBS scores in eighth grade, an IMP student would be predicted to outscore the traditional student by 15.2 points. An examination of the multiple choice scores showed a small gain of 4.27 points for IMP students, but this gain was not statistically significant.

The SAT-9 scores analyzed above were reported on a 1 through 99 scale. Based on these scores, the School District of Philadelphia characterizes student performance as being either below basic, basic, proficient, or advanced, with the last three categories considered as passing. An analysis of the scores of all the juniors at Girls' High School (including those excluded from the above study because they did not take the CTBS in eighth grade) found that 80% of the IMP students versus 43.5% of the traditional students received passing scores. Also, although IMP students comprised only 13.6% of all juniors at Girls' High, they accounted for 35.1% of the scores in the two highest (proficient and advanced) categories.

## Summary of ANCOVA study of 1998 SAT-9 Scores at Girls' High

Prepared by Edward (Ned) Wolff

Greater Philadelphia Secondary Mathematics Project

- 1) Normal curve equivalencies were used. These are reported on a 1 – 99 scale.
- 2) Students who started out in IMP and switched to Traditional were excluded. All other students were included as long as we could obtain complete eleventh grade math SAT-9 scores and eighth grade math CTBS scores. There were 27 IMP and 139 traditionally taught students in the study.
- 3) Using eighth grade CTBS math scores to control for baseline differences, we found:
  - a) IMP significantly improved composite math scores ( $p = .001$ ) and open-ended math scores ( $p < .001$ ). EMP students also did better than predicted on the multiple-choice section, but this difference was not statistically significant ( $p = .137$ ).
  - b) Using multiple regression techniques, the best-fit linear relationships for predicting SAT-9 math scores are:

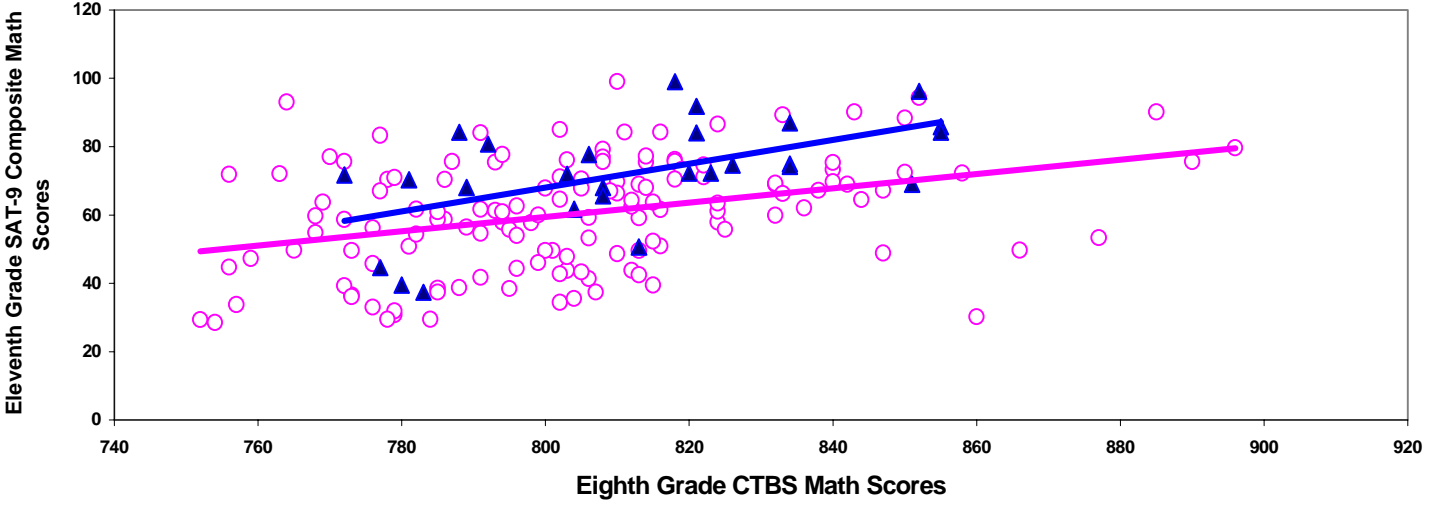
$$\text{Composite-math} = -122 + .227 \text{ CTBS} + 10.2 \text{ IMP}$$

$$\text{Multiple-math} = -144 + .252 \text{ CTBS} + 4.68 \text{ IMP}$$

$$\text{Open-math} = -101 + .202 \text{ CTBS} + 15.7 \text{ IMP}$$

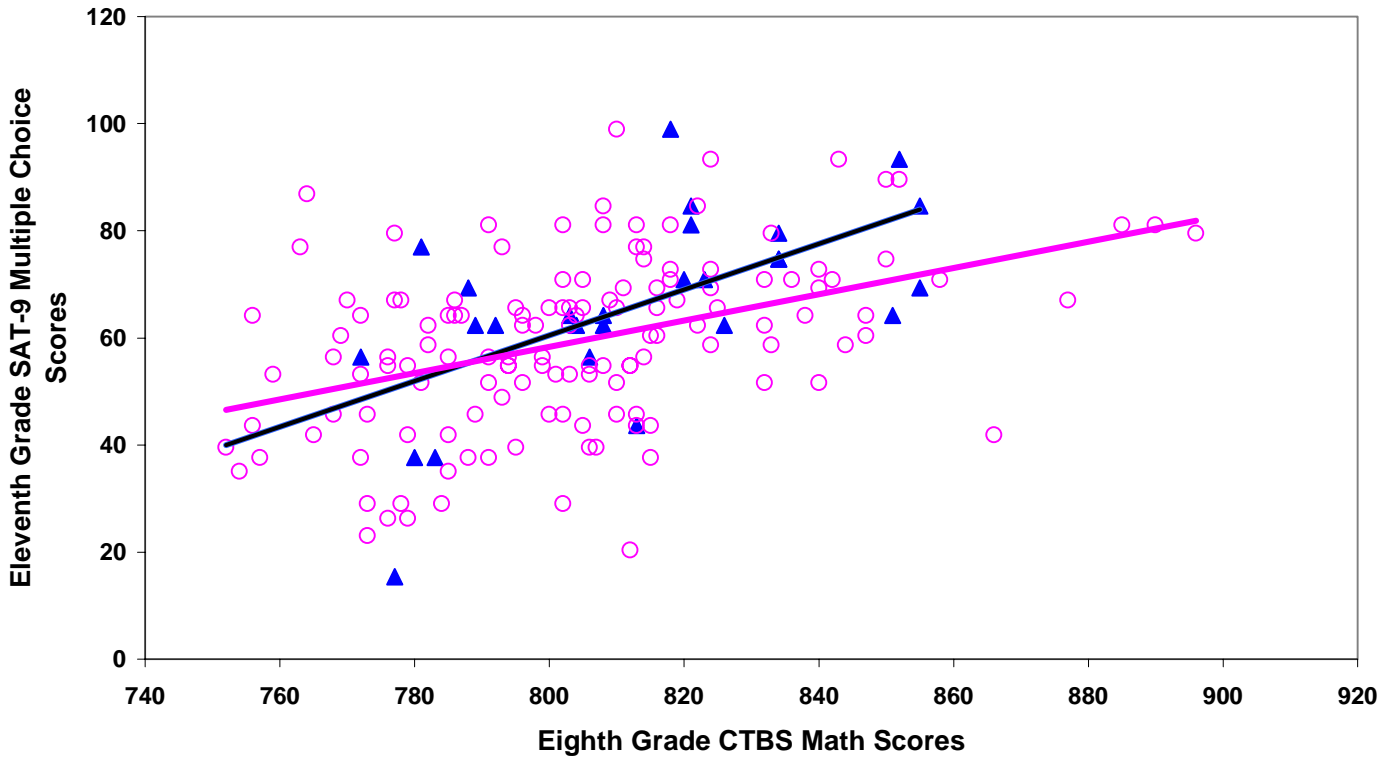
Here, the IMP variable takes on the value “1” for IMP students and “0” for traditional students. The coefficient in front of IMP shows the net gain of IMP students. For example, if an IMP student and traditionally- taught student have the same eighth grade CTBS scores, then the IMP student’s predicted composite math score would be 10.2 points higher than the traditional student’s score.

# Philadelphia High School for Girls





# Philadelphia High School for Girls



**Test Date: June 1996**  
**Harvard Quantitative Reasoning Test**

As part of their graduation requirements, Harvard undergraduate students must pass an exit exam in quantitative reasoning. Norman Webb from the University of Wisconsin selected ten questions from the Harvard exam. Among the topics covered by the questions were statistical reasoning and interpretation of graphs.

A test consisting of these ten questions was administered in June 1996 to 150 students completing their junior year at Central High School. Of these, 91 were enrolled in IMP-3 and the other 59 in Algebra II. Eighth grade scores on national tests were used as baseline data.

**Eighth Grade Scores of Central HS's 11<sup>th</sup> grade students:**

	<b>N</b>	<b>MEAN</b>	<b>STDEV</b>
<b>IMP</b>	<b>91</b>	<b>94.53</b>	<b>4.18</b>
Algebra II	59	93.85	4.59

**Questions taken from Harvard Exam given to Central HS's 11<sup>th</sup> grade students:**

<b>IMP</b>	<b>91</b>	<b>5.09</b>	<b>0.23</b>
Algebra II	59	2.31	1.72

The difference was statistically significant ( $p < .0001$ ).

**COMPARISON ON A QUANTITATIVE REASONING TEST  
OF GRADE 11 INTERACTIVE MATHEMATICS PROGRAM (IMP) STUDENTS  
WITH ALGEBRA 2 STUDENTS AT ONE HIGH SCHOOL**

April 24, 1997

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## Summary

Grade 11 students in four IMP Year 3 classes were compared to Grade 11 students in three algebra 2 classes at one high school in a large city located in an eastern state. Students were administered 10 multiple-choice items taken from a practice version of a quantitative reasoning test (QRT) developed by a prestigious university for first-year students. The test included items on data interpretation, probability, and statistics. IMP students significantly outperformed algebra 2 students as determined by tests of statistical significance. A matched-group analysis, which controlled for prior mathematics achievement, ethnicity and sex, produced consistent results, with IMP students significantly outperforming algebra 1 students.



# COMPARISON ON A QUANTITATIVE REASONING TEST OF GRADE 11 INTERACTIVE MATHEMATICS PROGRAM (IMP) STUDENTS WITH ALGEBRA 2 STUDENTS AT ONE HIGH SCHOOL

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An increasing number of studies have compared the mathematical knowledge of students enrolled in the Interactive Mathematics Program (IMP) with that of students enrolled in the traditional algebra 1, geometry, algebra 2 sequence. Accumulating evidence shows that IMP students perform as well as, if not better than, students taking the traditional curriculum, as measured by standardized norm-referenced tests such as the Scholastic Assessment Test (SAT), Pre-Scholastic Assessment Test (PSAT), and the Comprehensive Test of Basic Skills (Interactive Mathematics Program, 1995; Schoen, 1993; S. Chew, personal communication, November, 1996; Webb & Dowling, 1995a, 1995b, 1995c, 1996). These traditional instruments measure students' knowledge of very general mathematics skills and reasoning in mathematics. Probability, statistics, quantitative reasoning, and problem solving are given little or no attention on these instruments however. It is increasingly important for students to have knowledge in these areas. This has been recognized by the NCTM Curriculum and Evaluation Standards for School Mathematics (1989) and by various state standards such as South Carolina Mathematics Framework (1993), Illinois Academic Standards Project (1996), and New Jersey Mathematics Curriculum Framework (Rosenstein, Caldwell, & Crown, 1996). Therefore, we set out to examine the performance of IMP students on these critical criteria, which have not been focused upon by past research.

A series of three studies was designed to produce information on how well IMP students perform on activities using probability, statistics, reasoning, and problem solving. The IMP students were compared to students who were enrolled in the traditional algebra I (Dowling & Webb, 1997a), geometry (Dowling & Webb, 1997b) and algebra 2 sequence. This is the report of the grade 11 study that compared IMP Year 3 students with algebra 2 students at one high school in a large eastern city. The school is a college-preparatory magnet public high school located in a large city in the eastern United States. In 1994, the school enrolled over 2,000 students – 35 percent black; 17 percent Asian, 4 percent Latino, and 44 percent white. A large number of students who spoke English as a second language were enrolled. Students had to meet minimum requirements to attend School 3. About one-third of the applicants were accepted. Nearly all, 98 percent, of the students continue their education at universities or colleges.

To make valid comparisons between IMP and the traditional mathematics course sequence, specific controls were imposed on the design of these three studies. Each participating school had to provide grade 8 standardized norm-referenced mathematics test scores on a significant number of IMP and traditional mathematics students who were tested. An adequate number of students, as close to 50 as possible or more in each program, had to

be available to be tested. This meant that there had to be more than one IMP class at the target grade level. One or more teachers of the traditional mathematics course taken by students at the target grade level had to agree to participate in the study. The tests had to come from a source independent of IMP and had to be easily administered under the same conditions to classes of students in both course sequences. The inconvenience to teachers and students had to be kept to a minimum. Students' knowledge on as wide a range of content as possible was sought. Regional and school factors had to be reduced as much as possible. Effects had to be attributed to the curriculum rather than other factors such as teacher, school, or region.

Three studies were conducted. Each study was done in a different school at a different grade level with a different outcome measure. This design was chosen to meet the criteria above while maximizing the comparative information and minimizing the inference within any one school. Three different instruments were used. The study reported here compared the performance of grade 11 IMP Year 3 students with algebra 2 students on 10 multiple-choice items taken from a practice quantitative reasoning test (QRT) developed by a prestigious university for first-year students. The test focuses mainly on data interpretation. Its purpose is to gather evidence on using mathematics, probability, statistics, and Computation to solve problems. The test includes items on various topics: data and graph interpretation, probability, and basic understanding of statistics concepts, such as the standard deviation and the mean of a distribution. The test requires students to understand and apply arguments which are supported by numerical data.

### **Sample**

In May 1996, the QRT test was administered to a total of 133 students. Students were allowed to use any form of calculator on the test. The test was administered to students enrolled in four IMP Year 3 classes and three algebra 2 classes. Only grade 11 students were included in the analysis. Fifty-nine students out of 126 (47 percent) had attended public schools before enrolling in high school; the other 67 (53 percent) had attended private schools. The type of middle school was not indicated for seven students (Table 1, p. 11). In addition to the students' responses to each item scores on standardized tests, and student demographic characteristics, such as ethnicity and sex, were obtained from the school. The grade 8 standardized test scores reported by the school were the California Achievement Test (CAT), Comprehensive Test of Basic Skills (CTBS), Stanford Achievement Test (SAT), and the Educational Record Bureau (ERB) test. All students who had attended a public middle school had taken the CAT test. Other students who had attended private middle schools had taken a variety of standardized tests. Approximately 84 percent of the students took the CAT. The remaining 16 percent took one or more of the other tests.

A greater proportion of females than males took the exam; 72 out of 133 (54 percent of the test takers) were female (Table 2, p. 12). More than half of those tested (93 out of 133, or 70 percent) were IMP Year 3 students and the remaining 40 (30 percent) were students taking algebra 2. The ethnic composition of the total group was predominantly white (60

percent), then black (23 percent), Asian (8 percent), other (5 percent), and Hispanic (3 percent) (Table 3, p. 13). Because of rounding, disaggregated percentages will not always total 100 percent. A total of seven classes or groups taught by four different teachers or pairs of teachers were administered the test (Table 4, p. 14). The three algebra 2 classes were taught by the same teacher during the 1995-96 school year. Four IMP classes were taught by three teachers—two taught by two different teachers, one taught by these two teachers as a team, and one taught by one of these teachers and a third teacher.

## Results

Overall, IMP Year 3 students did significantly better on the test than the algebra 2 students (Table 5, p. 15). The item difficulty (the average of the proportion of students who correctly answered an item) was .50 for the IMP group and .24 for the algebra 2 group (Table 5, p. 15). The item difficulty levels ranged from .18 to .75 for the IMP group, and from .03 to .53 for the algebra 2 group (Table 12, p. 22). An "acceptable" item difficulty range for a five-options multiple-choice item is between .30 and .90. For the IMP group, 9 out of the 10 items were within this range. However, for the algebra 2 group only 3 out of the 10 items were within this "acceptable" range. Algebra 2 students had great difficulty with the test: their performance was essentially at the guessing level.

The items related to the application of the normal curve properties, especially the standard deviation, were relatively difficult for both groups (e.g., item 1; Table 6, p. 16). Other relatively difficult items, especially for the algebra 2 group, were those related to extrapolation using rates and percentages (items 4, 5, and 6). Item difficulties on these items ranged from .43 to .54 for the IMP group and from .10 to .23 for the algebra 2 group. IMP Year 3 students did considerably better on items related to probability concepts than algebra 2 students (items 7 and 8). The item difficulty values were .75 (item 7) and .67 (item 8) for the IW group and .53 and .38 respectively for the algebra 2 group.

The alpha reliability coefficient for a test provides an estimate of the accuracy of the test scores as indicated by the internal consistency, or degree to which a of the items in the test are consistent in rank ordering the students. The obtained reliability estimate for the total group ( $n = 133$ ) was .65. This is considered a reasonably high estimate, given the fact that the test was relatively short (only 10 items) and it covered a variety of topics. The standard error of measurement for the test was 1.36 raw score units (Table 5, p. 15). As expected, given the obtained range of item difficulty values for each group, the reliability estimate was higher for the IMP Year 3 sample (.56) than for the algebra 2 sample (.33).

Averaging the national percentile scores across students, discounting that not all students had taken the same test, the mean score on grade 8 mathematics test was significantly different in favor of IMP students (Table 7, p. 17). National percentile scores determined by different instruments are not equivalent. The mean scores computed here have to be interpreted very broadly. In a matched-group analysis, reported in the next section, only students with a score from the same grade 8 mathematics test were included in the analysis.

When using grade 8 CAT national percentile scores for the “public middle school” sample and grade 8 national percentile scores for the other standardized tests (i.e., a combination of CAT, CTBS, SAT, and ERB) for the “private” sample as covariates, the difference in QRT test scores between the IMP Year 3 and algebra 2 students was found to be highly significant ( $p < .0001$ ;  $p < .0001$ ) (Tables 8 and 9, pp. 18-19). When using the score obtained in the grade 8 standardized test in mathematics as a covariate, for the total group, the result was consistent: that is, the IMP group performed significantly better than the algebra 2 group ( $p < .0001$ ) (Table 10, p. 20).

The highest attainable score on the QRT test was 10. Students obtained scores ranging from 0 to 10. Two IMP students obtained a perfect score on the test. None of the algebra 2 students did this. Three students obtained a score of 0: one IMP student and two algebra 2 students. Additionally, males outperformed females on the test ( $p < .016$ ) (Table 11, p. 21; Table 13, p. 23). No significant differences in performance by ethnicity were found on mean test scores (Tables 12 and 13, pp. 22-23).

An analysis of variance (anova) was used to test for differences among mean scores across class periods. As mentioned before, a total of 7 classes (four IMP Year 3 classes and three algebra 2 classes) taught by four different teachers were administered the quantitative reasoning test (Table 14, p. 24). There were no statistically significant differences in mean total test score by class periods within any group, IMP Year 3 or algebra 2 (Tables 15 and 16, pp. 25-26). A series of anovas were performed with the purpose of testing for mean differences between class periods across treatment (IMP vs. algebra). Almost all the mean differences between all 12 possible pairwise combinations between IMP and algebra 2 classes were statistically significant **except** for one: teacher C-period 3 (IMP) with a mean of 4.44, and teacher A-period 7 (algebra 2) with a mean of 3.13.

### **Matched-Group Analysis**

Several variables—such as prior mathematical experience, sex, and ethnicity—could have influenced the outcome of the study. Upon entering high school, the group of IMP students who participated in the study had a higher average mathematics achievement than the group of algebra 2 students (see Table 17, p. 27). One way to control for this initial difference was to perform an analysis of covariance. The results of this analysis were discussed in the previous section of this paper. Another approach used to establish some statistical control over suspected nuisance variables possibly affecting students’ performance on the QRT test was the large-sample, matched-group Wilcoxon test. For this test, students from both groups were matched according to prior achievement. Only students who had taken the CAT test in grade 8 were included in this analysis. Students in both groups, a total of 110 students who had taken the CAT in grade 8, were rank-ordered—77 IMP Year 3 students, and 33 algebra 2 students. After ranking students on CAT scores, the two groups (IMP and algebra) were matched, with the two highest and comparable-scoring students paired, the next two comparable-scoring students paired, and so on, with the two lowest and comparable-scoring students forming the last pair. A total of 31 pairs were formed. Additionally, the

groups were formed taking into account ethnicity, sex, and the middle school attended. The main purpose of the pairing process was to form two groups (IMP Year 3 and algebra 2) that matched as closely as possible on mean CAT scores and by sex and ethnicity (Tables 17, 18 and 19, pp. 27-29).

The results of the matched-group analysis were consistent with those obtained in the analysis of the complete sample: The DOP Year 3 students outperformed the algebra 2 students. The large-sample Wilcoxon test comparing the group distribution was highly significant (Table 20, p. 30). The overall differences in mean test scores (5.42 for the IMP group and 2.39 for the algebra 2 group) and item difficulties (.54 for the IMP group and .24 for the algebra group) were larger than those obtained in the complete sample analysis (See Table 5, p. 15 and Table 21, p. 31). Also consistent with the results obtained in the complete sample analysis, males performed significantly better than females, although the difference in mean test scores and item difficulties were not as dramatic as those obtained in the prior analysis (see Table II, p. 21 and Table 22, p. 32).

The obtained item difficulty values of the IMP group in the matched-group analysis were slightly higher than those obtained in the complete sample analysis. On the other hand, the item difficulty values obtained by the algebra 2 group in the matched-group test were almost identical to those obtained before (Table 6, p. 16 and Table 23, p. 33). The item difficulty levels ranged from .23 to .84 for the IMP Year 3 group and from .03 to .52 for the algebra 2 group.

Differences in performance by item between IMP and algebra students were larger in the matched-group analysis compared to the complete sample analysis. For example, on items related to statistical concepts (specifically the application of the normal curve properties, items 1 to 3 on Table 23, p. 33), the difference between IMP and algebra 2 students was even greater for the matched-group analysis than it was for the complete sample analysis. The item difficulty values ranged from .23 to .68 for IMP students and from .03 to .26 for algebra students. Overall, IMP Year 3 students did significantly better than algebra 2 students on items related to graph interpretation and analysis using the slope concept (items 9 and 10) and extrapolation using rates and percentages (items 4, 5, and 6). Also consistent to prior findings, IMP students performed significantly better than algebra students on items related to probability concepts (items 7 and 8). The item difficulty values were .68 (item 7) and .71 (item 8) for the IMP Year 3 group and .52 and .36 respectively for the algebra 2 group.

The obtained reliability estimates were higher than those obtained in the complete sample analysis. This may be explained by the fact that the item difficulty values were slightly higher, especially for the IMP Year 3 group, compared to those obtained in the complete-sample analysis. Higher reliability estimates also suggest that the ability range in the subsample was broader than the complete group, or the subsample was more heterogeneous in ability. The obtained reliability estimate for the total matched-group ( $n = 62$ ) was .71. The reliability estimate was .60 for the IMP Year 3 group and .41 for the algebra 2 group.

## Conclusions

IMP Year 3 students scored significantly higher than algebra 2 students on 10 multiple-choice items taken from a practice version of a quantitative reasoning test developed by a prestigious university. Two analyses were applied to compare the performance of the groups: an analysis of covariance using grade 8 national percentile scores on standardized tests as a covariate and a “matched-group” large-sample Wilcoxon test. After establishing statistical controls over possible extraneous variables such as grade 8 CAT scores, sex, and ethnicity, the matched-group analysis confirmed the results obtained in the analysis of covariance. The overall differences in mean test scores and mean item difficulties obtained in the matched-group analysis were even larger than those obtained in the prior analyses.

On both analyses, males performed significantly better than females, although in the matched-group analysis the difference in mean test scores and item difficulties by sex were smaller than those obtained in the analysis of the full group. On both analyses, IMP students performed significantly better than algebra students on all items, including those requiring the application of statistical concepts such as the mean, the standard deviation, and normal curve properties.

The findings from this study strongly suggest that the IMP curriculum is successful in emphasizing reform-inspired topics such as probability and statistics. Overall, IMP Year 3 students demonstrated greater facility in applying probability and statistics concepts, interpreting data and analyzing graphs, and using rates and percentages to extrapolate than algebra 2 students.

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**Table 1**

**Distribution of Students by School and Course**

<b>Middle Schools</b>	<b>Total</b>		<b>IMP Year 3</b>		<b>Algebra 2</b>	
	<b>N</b>	<b>%</b>	<b>N</b>	<b>%</b>	<b>N</b>	<b>%</b>
Public	59	46.8	38	41.8	21	60.0
Private	67	53.2	53	58.2	14	40.0
Total	126 <sup>a</sup>	100.0	91 <sup>a</sup>	100.0	35 <sup>a</sup>	100.0

<sup>a</sup> Type of middle school was not reported for two IMP Year 3 and five Algebra 2 students.

**Table 2****Distribution of Students by Sex, Course, and Teacher**

Group	Total				IMP Year 3				Algebra 2			
	M	% <sup>a</sup>	F	%	M	%	F	%	M	%	F	%
Teacher A	14	35.0	26	65.0	-	-	-		14	35.0	26	65.0
Teacher B	11	45.8	13	54.2	11	45.8	13	54.2	-	-	-	-
Teacher C	13	52.0	12	48.0	13	52.0	12	48.0	-	-	-	-
Teacher B/ Teacher C	10	50.0	10	50.0	10	50.0	10	50.0	-	-	-	-
Teacher B/ Teacher D	13	54.2	11	45.8	13	54.2	11	45.8	-	-	-	-
<b>Total</b>	<b>61</b>	<b>45.9</b>	<b>72</b>	<b>54.1</b>	<b>47</b>	<b>50.5</b>	<b>46</b>	<b>49.5</b>	<b>14</b>	<b>35.0</b>	<b>26</b>	<b>65.0</b>

<sup>a</sup> Horizontal percentage.

**Table 3****Distribution of Students by Ethnicity and Course**

<b>Ethnicity</b>	<b>Total</b>		<b>IMP Year 3</b>		<b>Algebra 2</b>	
	<b>N</b>	<b>%</b>	<b>N</b>	<b>%</b>	<b>N</b>	<b>%</b>
Asian or Pacific Islander	11	8.3	6	6.5	5	12.5
<b>Black – not of Hispanic Origin</b>	31	23.3	19	20.4	12	30.0
<b>Hispanic</b>	4	3.0	3	3.2	1	2.5
<b>White – not of Hispanic Origin</b>	80	60.1	59	63.4	21	52.5
<b>Other</b>	7	5.3	6	6.5	1	2.5
<b>Total</b>	<b>133</b>	<b>100.0</b>	<b>93</b>	<b>100.0</b>	<b>40</b>	<b>100.0</b>

**Table 4****Distribution of Students by Period, Course, and Teacher**

<b>Teacher</b>	<b>Period 1</b>	<b>Period 2</b>	<b>Period 3</b>	<b>Period 4</b>	<b>Period 5</b>	<b>Period 7</b>	<b>Total</b>
	<b>N</b>	<b>N</b>	<b>N</b>	<b>N</b>	<b>N</b>	<b>N</b>	<b>N</b>
<b>Teacher A (Algebra 2)</b>	-	-	18	-	14	8	40
<b>Teacher B (IMP Year 3)</b>	-	-	-	24	-	-	24
<b>Teacher C (IMP Year 3)</b>	-	-	25	-	-	-	25
<b>Teacher B/ Teacher C (IMP Year 3)</b>	-	20	-	-	-	-	20
<b>Teacher B/ Teacher D (IMP Year 3)</b>	24	-	-	-	-	-	24
<b>Total</b>	<b>24</b>	<b>20</b>	<b>43</b>	<b>24</b>	<b>14</b>	<b>8</b>	<b>133</b>

**Table 5**  
**Summary, Statistics on the Test by Course**

	<b>Total</b>	<b>IMP Year 3</b>	<b>Algebra 2</b>
Number of students	133	93	40
Mean score	4.25	5.04	2.40
Standard deviation	2.30	2.12	1.52
Reliability (Alpha)	0 (3)	0 (1)	0 (2)
Standard error of measurement	1.36	1.40	1.25
Mean item difficulty	.42	.50	.24
Maximum attained score <sup>a</sup>	10 (2)	10 (2)	8 (1)
Minimum attained score <sup>a</sup>	0 (3)	0 (1)	0 (2)

<sup>a</sup> The number of students is indicated in parenthesis.

**Table 6****Item Difficulty on the Test by Course**

<b>Item</b>	<b>Total</b>	<b>IMP Year 3</b>	<b>Algebra 2</b>
1	.14	.18	.03
2	.46	.54	.28
3	.23	.29	.10
4	.43	.52	.23
5	.41	.54	.10
6	.33	.43	.10
7	.68	.75	.53
8	.58	.67	.38
9	.36	.42	.23
10	.36	.71	.45
<b>Total no. of Students</b>	<b>133</b>	<b>93</b>	<b>40</b>

**Table 7**

**Mean and Standard Deviation on Grade 8 Standardized Tests Scores by Course and Middle School**

Middle School	Total			IMP Year 3			Algebra 2		
	M	S.D.	N	M	S.D.	N	M	S.D.	N
Public Middle School									
<b>Mathematics</b> <sup>a</sup>	92.31	4.46	59	92.95	4.36	38	91.14	4.51	21
<b>English</b> <sup>a</sup>	91.14	7.82	59	92.87 <sup>c</sup>	5.80	38	88.00	9.97	21
Private Middle School									
<b>Mathematics</b> <sup>b</sup>	95.54	3.73	67	95.66	3.70	53	95.07	3.97	14
<b>English</b>	95.24	4.24	67	95.26	4.33	53	95.14	4.04	14
<b>Total</b>									
<b>Mathematics</b>	94.03	4.38	126	94.53 <sup>d</sup>	4.18	91	92.71	4.67	35
<b>English</b>	93.32	6.49	126	94.26 <sup>e</sup>	5.10	91	90.86	8.79	35

<sup>a</sup> California Achievement Test (CAT) in mathematics taken in grade 8.

<sup>b</sup> Students who attended a private middle school took a variety of standardized tests. Approximately 84% of the students took California Achievement Test (CAT). The remaining 16% took one or more of the following tests: Comprehensive Test of Basic Skills (CTBS), the Stanford Achievement Test (SAT), the Iowa Test of Basic Skills (IOWA), and the Educational Record Bureau (ERB) test.

<sup>c</sup> Statistically significant differences between IMP and algebra 2 using an analysis of variance ( $p < .021$ ).

<sup>d</sup> Statistically significant differences between IMP and algebra 2 using an analysis of variance ( $p < .037$ ).

<sup>e</sup> Statistically significant differences between IMP and algebra 2 using an analysis of variance ( $p < .008$ ).

**Table 8**

**Analysis of Variance: Total Test Score by Grade 11  
Course-Public Middle School**

<b>Source of Variation</b>	<b>Sum of Squares</b>	<b>Degrees of Freedom</b>	<b>Mean Square</b>	<b>F</b>	<b>Sig of F</b>
<b>Covariate:</b> Grade 8 Scores in Math	16.793	1	16.793	4.135	.0470
Main Effects Course	121.456	1	121.456	29.908	.0001
Explained	138.249	2	69.124	17.022	.0001
Residual	227.412	56	4.061		
Total	365.661	58	6.305		

**Table 9**

**Analysis of Variance: Total Test Score by Grade 11  
Course-Private Middle School**

<b>Source of Variation</b>	<b>Sum of Squares</b>	<b>Degrees of Freedom</b>	<b>Mean Square</b>	<b>F</b>	<b>Sig of F</b>
<b>Covariate:</b> Grade 8 Scores in Math	43.354	1	43.354	13.056	.0010
Main Effects Course	55.801	1	55.801	16.804	.0001
Explained	99.154	2	49.577	14.930	.0001
Residual	212.518	64	3.321		
Total	311.672	66	4.722		

**Table 10**

**Analysis of Variance: Total Test Score by Grade 11  
Course-Total Group**

<b>Source of Variation</b>	<b>Sum of Squares</b>	<b>Degrees of Freedom</b>	<b>Mean Square</b>	<b>F</b>	<b>Sig of F</b>
<b>Covariate:</b> Grade 8 Scores in Math	50.780	1	50.780	13.413	.0001
Main Effects Course	161.210	1	161.210	45.581	.0001
Explained	211.990	2	105.995	27.997	.0001
Residual	465.669	123	3.786		
Total	677.659	125	5.421		

**Table 11**

**Summary Statistics on the Test by Sex**

	<b>Male</b>	<b>Female</b>
Number of Students	61	72
Mean Score	4.93 <sup>a</sup>	3.67 <sup>a</sup>
Standard Deviation	2.25	2.19
Reliability (Alpha)	.61	.65
Standard error of measurement	1.41	1.30
Mean item difficulty	.49	.37
Maximum attained <sup>b</sup>	10 (2)	9 (1)
Minimum attained <sup>b</sup>	1 (4)	0 (3)

<sup>a</sup> Statistically significant differences were found using an analysis of variance ( $p < .016$ )

<sup>b</sup> The number of students is indicated in parenthesis.



**Table 12****Mean and Standard Deviation by Ethnicity and Course**

	<b>Total</b>			<b>IMP Year 3</b>			<b>Algebra 2</b>		
	<b>N</b>	<b>Mean</b>	<b>S.D.</b>	<b>N</b>	<b>Mean</b>	<b>S.D.</b>	<b>N</b>	<b>Mean</b>	<b>S.D.</b>
<b>Asian or Pacific Islander</b>	11	4.00	2.37	6	5.67	1.63	5	2.00	1.22
<b>Black – not of Hispanic Origin</b>	31	3.32	2.04	19	4.16	2.03	12	2.00	1.21
<b>Hispanic</b>	4	4.25	2.63	3	4.67	3.06	1	3.00	-
<b>White – not of Hispanic Origin</b>	80	4.59	2.27	59	5.27	2.06	21	2.67	1.77
<b>Other</b>	7	4.86	2.67	6	5.17	2.79	1	3.00	-
<b>Total</b>	133	4.25	2.30	93	5.04	2.12	40	2.40	1.52

**Table 13**

**Analysis of Variance: Total Test Score by Grade 11  
Course, Sex, and Ethnicity**

<b>Source of Variation</b>	<b>Sum of Squares</b>	<b>Degrees of Freedom</b>	<b>Mean Square</b>	<b>F</b>	<b>Sig of F</b>
<b>Main Effects</b>	237.567	6	39.595	10.884	.0001
Course	158.370	1	158.370	43.535	.0001
Sex	21.731	1	21.731	5.974	.016
Ethnicity	13.654	4	3.413	.938	.444
<b>2-Way Interaction</b> Course by Ethnicity	5.527	4	1.382	.380	.823
Course by Sex	.009	1	.009	.002	.960
Sex by Ethnicity	34.102	4	8.526	2.344	.059
<b>3-Way Interaction</b> Course by Sex by Ethnicity	3.921	2	1.960	.539	.585
<b>Residual</b>	418.346	115	3.638		
<b>Total</b>	696.812	132	5.279		

**Table 14****Total Test Score Means and Standard Deviations by Period, Course, and Teacher <sup>a</sup>**

<b>Teacher</b>	<b>Period 1</b>		<b>Period 2</b>		<b>Period 3</b>		<b>Period 4</b>		<b>Period 5</b>		<b>Period 7</b>	
	<b>M</b>	<b>S.D.</b>	<b>M</b>	<b>S.D.</b>	<b>M</b>	<b>S.D.</b>	<b>M</b>	<b>S.D.</b>	<b>M</b>	<b>S.D.</b>	<b>M</b>	<b>S.D.</b>
<b>Teacher A (Algebra 2)</b>	-	-	-	-	2.22	1.17	-	-	2.21	1.25	3.13	2.42
<b>Teacher B (IMP Year 3)</b>	-	-	-	-	-	-	5.04	2.03	-	-	-	-
<b>Teacher C (IMP Year 3)</b>	-	-	-	-	4.44	2.49	-	-	-	-	-	-
<b>Teacher B/ Teacher C (IMP Year 3)</b>	-	-	5.25	1.41	-	-	-	-	-	-	-	-
<b>Teacher B/ Teacher D (IMP Year 3)</b>	5.50	2.25	-	-	-	-	-	-	-	-	-	-

<sup>a</sup> all pairwise comparisons of means between IMP classes of algebra 2 classes were statistically significant except for teacher C-period 3 (IMP) and teacher A-period 7 (algebra 2) using an analysis of variance.

**Table 15**

**Analysis of Variance: Total Test Score by IMP Year 3 Class Periods**

<b>Source of Variation</b>	<b>Sum of Squares</b>	<b>Degrees of Freedom</b>	<b>Mean Square</b>	<b>F</b>	<b>Sig of F</b>
<b>Main Effects Course</b>	14.960	3	4.987	1.118	.346
<b>Explained</b>	14.760	3	4.987	1.118	.346
<b>Residual</b>	396.868	89	4.459		
<b>Total</b>	411.828	92	4.476		

**Table 16**

**Analysis of Variance: Total Test Score by Algebra 2 Class Periods**

<b>Source of Variation</b>	<b>Sum of Squares</b>	<b>Degrees of Freedom</b>	<b>Mean Square</b>	<b>F</b>	<b>Sig of F</b>
<b>Main Effects Course</b>	5.257	2	2.628	1.153	.327
<b>Explained</b>	5.257	2	2.628	1.153	.327
<b>Residual</b>	84.343	37	2.280		
<b>Total</b>	89.600	39	2.297		

**Table 17**

**Distribution of Students by School and Course  
(Matched-Group Analysis)**

<b>Middle School</b>	<b>Total</b>		<b>IMP Year 3</b>		<b>Algebra 2</b>	
	<b>N</b>	<b>%</b>	<b>N</b>	<b>%</b>	<b>N</b>	<b>%</b>
<b>Public</b>	31	50.0	14	45.2	17	54.8
<b>Private</b>	31	50.0	17	54.8	14	45.2
<b>Total</b>	62	100.0	31	100.0	31	100.0

**Table 18**

**Distribution of Students by Sex and Course  
(Matched-Group Analysis)**

<b>Sex</b>	<b>Total</b>		<b>IMP Year 3</b>		<b>Algebra 2</b>	
	<b>N</b>	<b>%</b>	<b>N</b>	<b>%</b>	<b>N</b>	<b>%</b>
<b>Female</b>	40	64.5	19	61.3	21	67.7
<b>Male</b>	22	35.5	12	38.7	10	32.3
<b>Total</b>	62	100.0	31	100.0	31	100.0

**Table 19**

**Distribution of Students by Ethnicity and Course  
(Matched-Group Analysis)**

<b>Ethnicity</b>	<b>Total</b>		<b>IMP Year 3</b>		<b>Algebra 2</b>	
	<b>N</b>	<b>%</b>	<b>N</b>	<b>%</b>	<b>N</b>	<b>%</b>
<b>Asian or Pacific Islander</b>	4	6.5	1	3.2	3	9.7
<b>Black-not of Hispanic Origin</b>	18	29.0	8	25.8	10	32.3
<b>Hispanic</b>	2	3.2	1	3.2	1	3.2
<b>White-not of Hispanic Origin</b>	33	53.2	17	54.9	16	51.6
<b>Other</b>	5	8.1	4	12.9	1	3.2
<b>Total</b>	62	100.0	31	100.0	31	100.0

## Table 20

### Large-Sample Matched-Group Wilcoxon Test Results 1

Treatment: IMP Year 3 Vs. Algebra 2  
Observed or Outcome Variable: Total Test Score

RESULTS	
E (T)	248.00
VARIANCE (T)	2586.50
STANDARD DEVIATION	50.86
P .025	147.81
P .975	348.19
T	481.40

$$H_0: M_d = 0$$
$$T > T_u$$

*∴ therefore*

Reject  $H_0$

Z-Statistic Approximation, continuity corrected

$Z = 4.5814$     2-Tail p value = 0.0001\*\* (Highly Significant)

Limits for the two-tailed Confidence Interval (95%)

$$2 \leq M_d \leq 4$$

---

<sup>1</sup> The statistical package NONPAR developed by Dr. Ronald Serlin from the University of Wisconsin-Madison was used to perform the Wilcoxon test.



**Table 21**

**Summary Statistics on the Test by Course  
(Matched-Group Analysis)**

	Total	IMP Year 3	Algebra 2
Number of students	62	31	31
Mean score	3.90	5.42	2.39
Standard deviation	2.45	2.20	1.61
Reliability (Alpha)	.71	.60	.41
Standard error of measurement	1.32	1.39	1.24
Mean item of difficulty	.39	.54	.24
Maximum attained score <sup>a</sup>	10 (1)	10 (1)	8 (1)
Minimum attained score <sup>a</sup>	0 (2)	0 (1)	0 (1)
Grade 8: <i>California Achievement Test</i> (CAT) <sup>b</sup>	93.69 (3.73)	93.71 (3.75)	93.68 (3.77)

<sup>a</sup> The number of students is indicated in parenthesis.

<sup>b</sup> The standard deviation is indicated in parenthesis.

**Table 22**

**Summary Statistics on the Test by Sex  
(Matched-Group Analysis)**

	Male	Female
Number of students	22	40
Mean score	4.41	3.63
Standard deviation	2.56	2.37
Reliability (Alpha)	.70	.71
Standard error of measurement	1.40	1.28
Mean item of difficulty	.44	.36
Maximum attained score <sup>a</sup>	10 (1)	9 (1)
Minimum attained score <sup>a</sup>	1 (4)	0 (2)

<sup>a</sup> The number of students is indicated in parenthesis.

**Table 23**

**Item Difficulty on the Test by Course  
(Matched-Group Analysis)**

<b>Item</b>	<b>Total</b>	<b>IMP Year 3</b>	<b>Algebra 2</b>
1	.13	.23	.03
2	.47	.68	.26
3	.26	.39	.13
4	.36	.45	.26
5	.34	.58	.10
6	.23	.39	.07
7	.60	.68	.52
8	.53	.71	.36
9	.36	.48	.23
10	.65	.84	.45
Total no. of Students	62	31	31

## Test

### **To the student:**

This test consists of 10 multiple-choice questions. Calculators are allowed. If it is necessary, the test administrator will provide you with additional paper to work the problems.

Before beginning the test please complete all of the information requested on the cover sheet.

Please circle your choice to each test question in the booklet. Try to answer every questions, but do not spend too much time on any one question. If you have time at the end of the test, go back and answer any questions that you have skipped. If you are not sure of an answer, circle the answer you think is right.

If you want to change an answer, erase your first mark completely. Then circle the choice you think is correct. Circle only one answer for each question.

You may start answering the questions as soon as you complete your name and the other information requested on the cover sheet. Please write your name on the top of each page.

## Cover Sheet

Student's Name: \_\_\_\_\_

Grade: \_\_\_\_\_

Mathematics Course Title: \_\_\_\_\_

Class Period: \_\_\_\_\_

Teacher: \_\_\_\_\_

Gender: (circle one)    F    M

(optional)

- Ethnicity:  
(circle one)
- (1)    American Indian or Alaskan
  - (2)    Asian or Pacific Islander
  - (3)    Black (not of Hispanic origin)
  - (4)    Hispanic
  - (5)    White (not of Hispanic origin)
  - (6)    Other

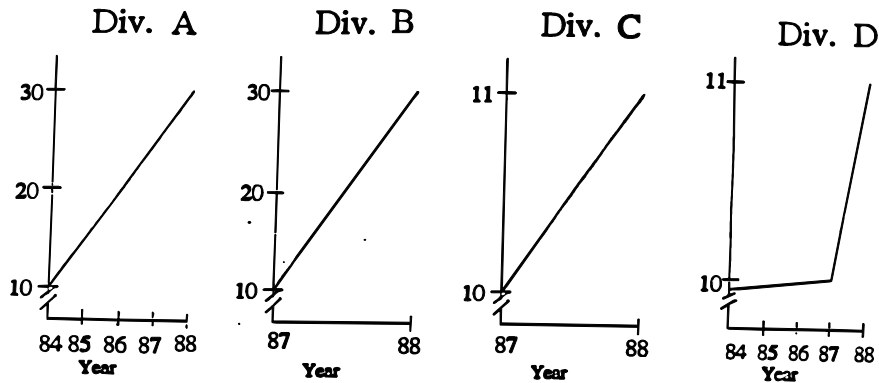
Student Name: \_\_\_\_\_

The oil consumption of Town A in the year 1985 was 60,000 barrels. The consumption increases at a rate of 6% per year. (Use this information to answer questions 4 to 6.)

4. By what percent did Town A's oil consumption increase from 1985 to 1988?
  - a. 6%
  - b. 12%
  - c. 18%
  - d. 19%
  - e. 26%
  
5. Assuming that oil consumption continues to increase by 6% per year, approximately how many years will it take for the town's annual oil consumption to reach 240,000 barrels?
  - a. 12 years
  - b. 24 years
  - c. 36 years
  - d. 46 years
  - e. 50 years
  
6. The oil consumption for a nearby metropolitan area, City B, increases at a rate of 10,000 barrels each year. City B used 200,000 barrels in 1985. Assume that oil consumption continues to increase indefinitely for both Town A and City B at the given rates. Which of the following statements is true?
  - a. Town A will consume more oil per year than City B by the year 2005.
  - b. Town A will eventually consume more oil per year than City B, but after the year 2005.
  - c. Town A's annual oil consumption will always remain under half of City B's.
  - d. Town A's annual oil consumption will never exceed City B's, but will come within 10,000 barrels of City B's consumption.
  - e. None of the above is true.

Student Name: \_\_\_\_\_

9. The head of Division A in a large corporation was pleased with the revenue growth in his division over the past several years. In a meeting with his supervisor, he presented her a graph of the revenue in his division for the years 1984 to 1988, inclusive, pointing out that the 1984 revenue was \$10 million and that the revenue had increased linearly until it reached \$30 million in 1988. (See the graph for Division A below.) Which of the following is the best interpretation of the slope of his graph?
- The average yearly revenue for the period from 1984 to 1988.
  - The total revenue for the period from 1984 to 1988.
  - The increase for the period from 1984 to 1988.
  - The yearly increase in revenue.
  - The yearly percent increase in revenue.
10. The supervisor wanted to see how the other three divisions under her control compared to the division she had just seen. She asked each of the other three division leaders to submit a graph of the revenue in his or her division. She now has the follow graphs.



(all revenue given in millions of dollars)

Which of the following statements is true?

- During the period 1987-1988, the revenues in Division D increased at a rate greater than the rate of increase in Division C.
- During the period 1987-1988, the revenues in Division B increased at a rate less than the rate of increase in Division A.
- During the period 1987-1988, the rate of increase of revenue was the same in Division B and Division C.
- (a), (b), and (c) are all true.
- None of (a), (b), and (c) are true.