

**Computer-Aided Instruction in  
Mathematics: Improving Performance  
in an Inner City Elementary School  
Serving Mainly English Language  
Learners**

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**Abstract**

Achievement of students in urban schools has long been a concern for educators in the United States. A National Center for Educational Statistics report in 2004 (NCES, 2004) showed how the National Assessment of Educational Progress (NAEP) mathematics assessment results for the nation's major urban areas were below the country as a whole. This study reports on the results in one urban school as they implemented a computer-aided instruction program to supplement mathematics instruction. The intervention focused on the use of the *A+dvanced Learning System* and *Performance Power* to individualize supplementary mathematics instruction. Results showed that the school's achievement as compared to national norms increased over successive years.

**Introduction**

Achievement of students in urban schools has long been a concern for educators in the United States. A National Center for Educational Statistics report in 2004 (NCES, 2004) showed how the National Assessment of Educational Progress (NAEP) mathematics assessment results compared between the nation's major urban areas and the country as a whole. Needless to say, the urban schools performed substantially below the country as a whole. A brief search of the Internet raises a number of websites whose concern is academic achievement in urban schools. The No Excuses Project of the Heritage Foundation provides one such site ([www.noexcuses.org](http://www.noexcuses.org)). The subtitle for the website is "lessons from high-performing, high-

poverty schools." The theme is to provide examples of unique schools that overcome the perceived disadvantage of urban education and poverty to excel.

Compounding the problem of urban education is the density of English Language Learners. The discrepancy between the academic performance of ELL students and the student body at large has long been documented (NCES). One article (Cocking & Chipman, 1989) documented the link between language and mathematics achievement. In this article, the reasons why the mathematical abilities of bilingual students fall increasingly behind students who speak English as their primary language are explored.

For the last twenty years, the search has been constant for methods to improve student achievement. Two current emphases in education may have particular application to the problems noted above. The first is assessment to inform instruction, often called "formative assessment." It has been said that one hope for students is short, frequent assessment that informs teachers about what students need to learn.

The second area is computer delivered assessment and instruction. The basis on which computers can help in these areas is described in a white paper by Trautman (2002). The paper discussed the research that shows how computers can be used to individualize instruction and provide assessment. The individual attention that students need, effective practice, and individualized instruction can be provided by educational software.

These two emphases came together in one urban, parochial school. Computer-based assessment and instruction was provided at St. Pius V Catholic School in the Mott Haven section of the Bronx, New York. This study investigates the intervention and results that were found at this inner city, parochial school, serving an immigrant, largely English language learning population.

*St. Pius V Catholic School*

Saint Pius V Elementary School is a parish school in the Mott Haven section of the South Bronx. Mott Haven is one of the poorest parts of New York City. St. Pius V opened its doors for the first time in September of 1913, serving primarily the needs of Irish immigrants in the South Bronx. The faculty at that time was composed chiefly of nuns from the Blauvent Dominican religious order.

Since the late 1960s and into the early 1970s, the neighborhood has become home to Hispanic and African American families from Puerto Rico, the Dominican Republic, and the Caribbean islands. Currently 85% of the students are Hispanic and 15% are African American. Approximately 80% of the children come from homes where English is not the primary language.

The mission of the school today is essentially the same as it was 100 years ago – to introduce its students to the social poise and essential academic skills that will ensure entry into the productive work force. The goal is, in the most literal sense, that no student should be left behind. Historically, the model for education has been the advancement of a group of students through the grades. This advancement can be likened to the Greek phalanx, a row of troops marching in closed ranks, side by side, with spears extended to the front. In theory, they represent an impenetrable body that advances unimpeded against any enemy. To linger a moment with the military metaphor, this supposition proved to be erroneous. Light infantry could charge a phalanx from the side and break through with short swords; there was neither the time nor the space for the phalanx to turn 90 degrees and meet the advancing foe.

Herein lies the strength and the weakness of what inner city Catholic schools have been doing since the nineteenth century. They have offered a rigid and highly structured program that rounds the rough edges of students and offers up the essential instruction of American schooling.

Looking at the photograph of the first graduating class of St. Pius V Elementary School, gracious and gentrified 14-year-olds, the girls in ankle-length gowns and the boys in dark blue suits with white shirts and high collars are seen. The accomplishments of such schools for the newly arrived poor have been extraordinary.

Let us now look at St. Pius V Elementary in the current time, 2004. The students are a newly arrived population, largely Dominican, with a strong representation of Puerto Rican and African American students. St. Pius V continues to require uniforms and a level of civility not found on the streets of the Bronx. St. Pius V continues with the phalanx as the model for the delivery of education. There is a supposed uniform body of students marching through their requirements as one; where everyone progresses at the same rate. There are important aspects, however, in which the world has turned many times at dazzling speed.

The first change is that the achievement of students in city schools, both public and parochial, is watched carefully. Performance of the schools is disclosed in detail in district reports, local newspapers, and even in real estate advertisements. Once scores become public knowledge, there is immediate pressure to continue to improve. Here is the first point of entry for computers to help with improving academic performance.

The second change is that the job market and the road to advancement are very different from the early years of St. Pius V. The only white-collar occupation available to the young ladies from the class of 1913 would have been as a secretarial job in an office. For young men, a few would go to college and others would find employment in local businesses. Today, the possible

trajectories are infinitely more varied. At the low end, there is welfare. There is still the white-collar middle class, but the road is longer and wider than it was a hundred years ago. The range of career choices has expanded dramatically, but the range of skills and necessary learning has also increased. One example is the need for technology skills for access to information. Beyond the expanded career opportunity, there is the possibility of expanded college and professional school opportunities for those with higher abilities. With the variety of skills and the variety of paths to advancement, the phalanx is obsolete. Now we need to identify the needs of all students and give them work at their level. We need to be able to challenge superior students at their level and provide expanded learning opportunities for the gifted. Here again computers can play a decisive role.

A further area of concern is curriculum. Standardized test results call attention to academic performance in areas that lie somewhat beyond the comfort zone of the teachers. For example in mathematics, the scores at St. Pius V were substandard in the areas of measurement, geometry, ratios and proportions, and word problems. These are areas where teachers often feel less comfortable in their abilities to provide instruction tuned to the needs of the students.

As with all schools, there are constraints at St. Pius V Elementary School. These are constraints of resources, staff, and funding. Since the 1950s, when the Catholic schools could no longer count on the religious orders to provide staffing, St. Pius V has worked under strained conditions. It has been a struggle to pay the teachers' salaries, which now comes to 60% of the pay rate in the New York City public schools. As a consequence, many of the teachers pass through St. Pius V while completing their education requirements to become certified. By the time they are fully conversant with the curriculum and the best instructional methodology, they move on to better paying jobs, better benefits, more preparation periods, and more abundant

resources. Once again, St. Pius V looks at a deficit that the computer can address. As there is staff turnover, instruction can remain consistent because instructional software can efficiently assess performance and provide lessons to address areas of need.

Finally, there is the matter of special needs and oppositional students. When St. Pius V opened its door almost 100 years ago, special education was no more than an apprehensive glint in the eyes of educators. Now it accounts for 12% of the population of the New York City school system. Computers have proven to be an excellent source of non-intrusive instruction for students with special needs (Trautman, 2002).

With all of these factors in mind, in the fall of 2002, St. Pius V embarked on a comprehensive program of computer-aided instruction. This required a major commitment to equipment, to staffing, to software, and to technology-friendly teachers. We chose to narrow our emphasis exclusively to mathematics. It was felt that mathematics would be the easier subject to address and that heightened performance in mathematics would lead to higher performance in other areas.

### Method

St. Pius V equipped a computer lab with a fully functional networked computer for each student when classes came to the lab. In order to ensure optimal results, every student came to the computer lab with their class for a 40-minute class period three times a week. The lab is in use nonstop throughout the day, including the various lunch periods. During each class period, the students are constantly solving problems on the computer. Their work is being recorded, graded, and tabulated over the network. At any given moment, four or five students are seeking assistance from the instructors in the lab for the problem on the screen. The pace is somewhere between brisk and furious, but as an intensified instructional environment, it is unsurpassed.

The program has now been in operation for two years, and data is being recorded and computed continuously. At the start of the school year, every student in every class takes the *Performance Power* assessment test in mathematics at his or her enrolled grade level. The score is recorded and, after the test, each student is given computer-based instruction at that same grade level and is given the test again. By November of the first year, students were passing the assessment test for their grade level. By January in the first year of this program, about 15% of each class passed the assessment at their grade level.

As they passed the assessment test for their grade level, they were anointed as “grade-jumpers,” and their photograph appeared in a gallery in the entrance hall to the school. Next, they started doing math at the next higher grade level, but only in the computer lab. In the classroom, they received mathematics instruction at the level in which they were currently enrolled. In the second year of the intervention, they used *A+LS* software in the computer lab in mathematics. Upon completion of the next higher grade level lessons, they took the assessment test for that grade level.

*Procedures*

In the fall of the 2002-2003 school year, the St. Pius V computer laboratory was equipped with approximately 30 computers. Each computer was a Pentium II class computer or better with the Windows 2000 operating system and a minimum of 128 MB of RAM, a six gigabyte hard drive, color monitor, and mouse. The computers were all part of a local area network. The educational software and associated data was stored on the network server.

In the fall of the 2002-2003 school year, the computer laboratory was equipped with Performance Power: Standards-Based Assessment Software by AGS. During the 2002-2003 school year, each second grade through eighth grade class at St. Pius V was scheduled to come to the computer lab for three 40-minute periods each week. *Performance Power* provided skill-based assessment, immediate feedback, and a teacher management tool to help pinpoint students' learning needs. Performance Power was used as an assessment tool and also as a remediation tool where students received immediate feedback regarding their performance. As a result, students were able to correct mistakes and learn. In essence, the first year of the program used assessment with immediate feedback as a means to improve student performance.

In the second year of the program, the *A+dvanced Learning System (A+LS)* was added to *Performance Power*. In the 2003-2004 school year, the students were initially assessed with *Performance Power* to determine their current functioning level. Then, the lessons for the student's current enrolled grade were assigned to the student from *A+LS*. Upon successful completion of the assignment list, the student was given the *Performance Power* assessment again. If the student showed mastery of the objectives for the current school year on *Performance Power*, he/she was subsequently given an assignment list of *A+LS* lessons for the following school year. Ultimately, in the second year of the program, *Performance Power* was

used as an assessment-feedback tool, and the *A+dvanced Learning System* was used to provide instruction, assessment, and feedback.

Throughout this time, the Iowa Test of Basic Skills (ITBS) was used by St. Pius V to assess student learning. The ITBS is given each year in March to grades two through eight. Because of the availability, the ITBS test results were used as the independent measure of student performance at St. Pius V. ITBS results are, therefore, used to determine the effectiveness of the computer-aided instruction intervention. It should be noted that for an unknown reason, the ITBS was not administered to the eighth grade class in 2002. The absence of this data will be noted in the results tables in the appendices.

Because the ITBS is a norm-referenced test, the national normative sample in effect is the comparison group for this study. As a result, this study is a nonequivalent control group design.

#### *Research Questions*

1. What is the increase in student performance in mathematics in year one of the program at St. Pius V as compared to national normative data?
2. What is the increase in student performance in mathematics in year two of the program at St. Pius V as compared to national normative data?
3. What is the increase in student performance in language arts in year one of the program at St. Pius V as compared to national normative data?
4. What is the increase in student performance in language arts in year two of the program at St. Pius V as compared to national normative data?

#### *Formal Statistical Hypotheses*

1. There is a statistically significant increase in student performance on mathematics on the ITBS from 2002 to 2003 as compared to national norms.

2. There is a statistically significant increase in student performance on mathematics on the ITBS from 2003 to 2004 as compared to national norms.
3. There is a statistically significant increase in student performance on language arts on the ITBS from 2002 to 2003 as compared to national norms.
4. There is a statistically significant increase in student performance on language arts on the ITBS from 2003 to 2004 as compared to national norms.

## Results

Before reporting the results of the analysis of Iowa Test of Basic Skills (ITBS) scores at St. Pius V, it is important to disclose what scores are being compared. In all cases, the scores reported were percentile ranks for the national school norms of the ITBS. However, percentile ranks are not suitable for parametric statistical analysis because percentile ranks do not form an equal interval scale. Therefore, all scores were transformed to normal curve equivalents (NCE). It is the normal curve equivalents that are reported in all tables in this report and are used for the statistical analysis.

### *ITBS Mathematics Changes from 2002 to 2003*

The first research question on which to report is: What is the increase in student performance in mathematics in year one of the program at St. Pius V as compared to national normative data? The results of the ITBS testing for the 2002 year as compared to the 2003 year are presented in Appendices C, D, E, and F. The results of the statistical analyses are presented in Appendix A. However, perhaps the best summary of the data is the graphic representation shown in Figure 1.

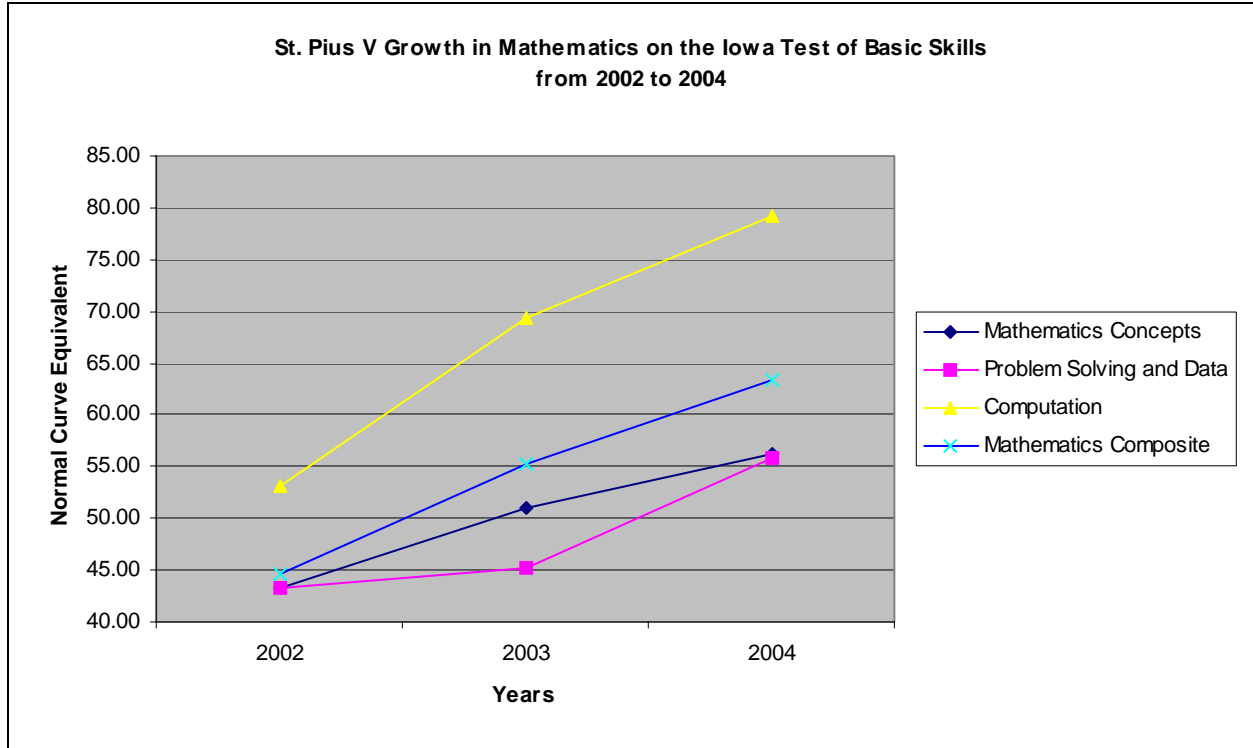


Figure 1. Chart of ITBS Mathematics Results

Overall, it can be seen that the trend of the St. Pius V mathematics scores is on the rise. For the moment, the consideration will be for the changes from 2002 to 2003. The school average for the Mathematics Composite score rose by seven Normal Curve Equivalent (NCE) points, the Computation NCE rose 16.2 points, and the Mathematics Concepts NCE rose 7.7 points. The increase was statistically significant for the Mathematics Composite ( $t = 123.53, p < .01, \eta^2 = .51$ ), Mathematics Concepts ( $t = 88.86, p < .01, \eta^2 = .36$ ), and Computation ( $t = 186.74, p < .01, \eta^2 = .76$ ). The  $\eta^2$  show the effect size to be important in regard to the gains that were made. While the gain on the Problem Solving and Data scale was significant ( $t = 22.61, p < .01$ ), the effect size was negligible ( $\eta^2 = .09$ ). This negligible effect size is readily seen on the graph in *Figure 1*.

The results were not uniform across all scales in grade levels. The most consistent results were on the Computation scale. Grades two through six had significant growth, but the seventh grade class actually showed a significant drop in score (Appendix A). The gains on the Composite scale were also consistent. Four of the six grade levels showed significant gains, while grades five and seven showed no significant difference. On the remaining scales, Mathematics Concepts and Problem Solving, two or three grade levels showed significant increases while the remaining grade levels showed nonsignificant changes.

So, the picture is this. In the first year of the program where the *Performance Power* software was used, the St. Pius V School showed a significant increase in the school average for Mathematics Composite Score on the ITBS as compared to the previous year and the expected change based on the national normative sample. The increase is statistically significant and the effect score, as measured by the  $\eta^2$  value, shows the difference to be important.

#### *ITBS Mathematics Changes from 2002 to 2003*

The second research question on which to report is: What has been the increase in student performance in mathematics in year two of the program at St. Pius V as compared to national normative data? As the reader will recall, in the second year of the study, the use of the *A+LS* instructional software was introduced. The results on the ITBS show that St. Pius V made significant gains in all areas of mathematics. The gains on the Composite scale were 8.18 points on the NCE. Those gains were statistically significant ( $t = 96.94, p < .01$ ) and important ( $\eta^2 = .38$ ). The gains were also more consistent than those of 2002 to 2003. The gains on Mathematics Concepts were 5.22 points on the NCE ( $t = 62.55, p < .01, \eta^2 = .24$ ). The Mathematics Problem Solving and Data gain was 10.5 points on the NCE ( $t = 125.84, p < .01, \eta^2 = .49$ ), and the

Computation gain was 9.84 on the NCE ( $t = 117.79, p < .01, \eta^2 = .46$ ). In other words, significant gains were made on all scales of the Iowa Test of Basic Skills. Also, the gains between 2003 and 2004 were considerably more consistent than those of 2002 to 2003.

Therefore, in the second year of the study, where the instructional intervention through the *Advanced Learning System* was added to *Performance Power*, St. Pius V again showed significant gains on its Iowa Test of Basic Skills mathematics scores.

#### *ITBS Language Arts Changes from 2002 to 2003*

One of the hypotheses that inspired St. Pius V to focus on mathematics in the computer laboratory was that improving mathematics skills would also result in gains in language arts abilities. This section of the report focuses on those results. The formal research question was this: What is the increase in student performance in language arts in year one of the program at St. Pius V as compared to national normative data?

The chart in *Figure 2* graphically shows the changes over time. The Language Arts scores on the ITBS national school norms show a clear trend upward over the three testing years. The Language score is a measure of a student's abilities to understand and use proper grammar in written language. In addition, the Reading scores show a decline from 2002 to 2003 and a gain to above the 2002 starting point from 2003 to 2004.

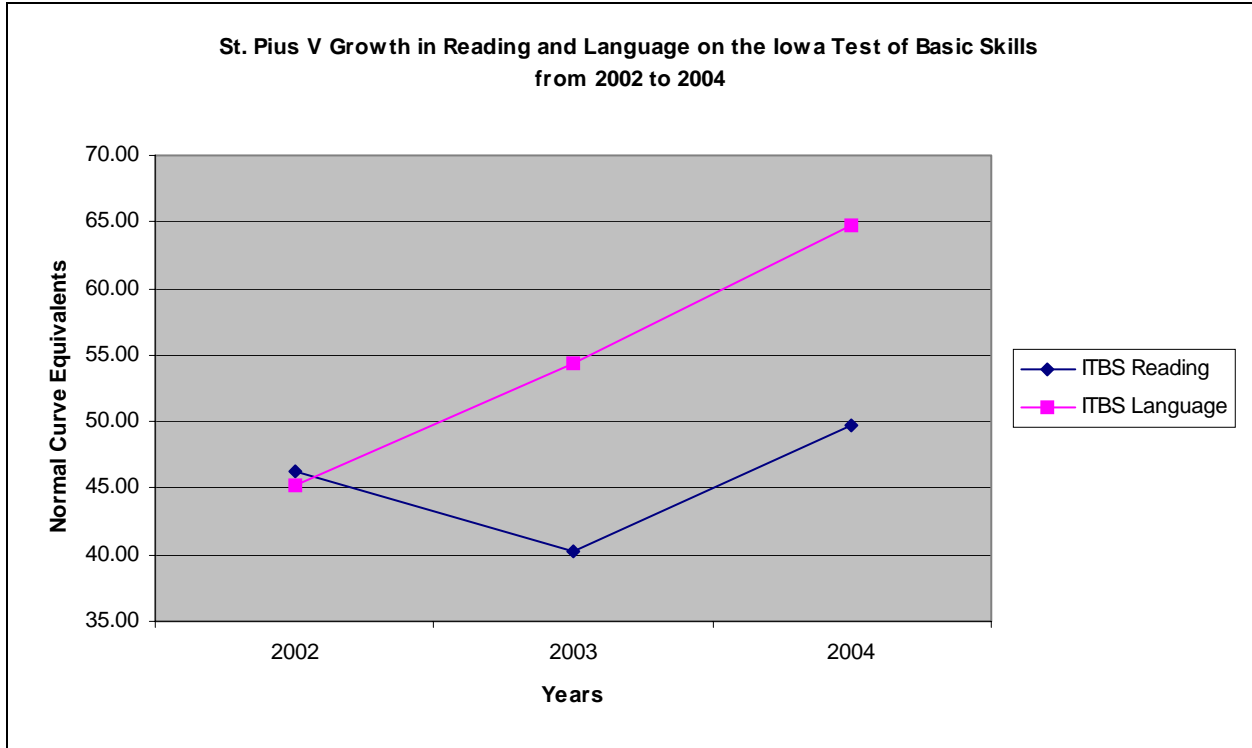


Figure 2 Chart of ITBS Language Arts Results

The normal curve equivalents for St. Pius V began below the national average in both Reading and Language. Following the first year's intervention, the Language score increased significantly to a normal curve equivalent of 54.4. The increase was statistically significant ( $t = 106.59, p < .01$ ), and the effect size was large ( $\eta^2 = .43$ ). The changes were not as had been hoped for in reading. In fact, the Reading score on the ITBS for St. Pius V declined significantly between 2002 and 2003 ( $t = -57.54, p < .01$ ), but the effect was smaller than the effect for Language ( $\eta^2 = -.28$ ). These results were quite consistent across the grade levels. Reading scores declined in three of the grade levels, two grade levels had no change, and one grade level increased its reading score slightly (Appendix H). The scores for the grade levels were consistent on the Language Scores. Five of the six grade levels tested showed gains, while one had no significant change (Appendix H).

*ITBS Language Arts Changes from 2002 to 2003*

The final research question to be presented was the increase in student performance in language arts in year two of the program at St. Pius V as compared to national normative data. The results are seen graphically in *Figure 2*. Both Reading ( $t = -123.64, p < .01$ ), and Language ( $t = 114.47, p < .01$ ), showed significant gains. These gains placed the St. Pius V reading normal curve equivalents on the ITBS at 63.68, and the normal curve equivalent at 64.38. The gains were significant across the grade levels.

Discussion

The increasing scores at St. Pius V Elementary School are certainly hopeful with regard to the use of computer-aided instruction in an inner city school. The initial focus was on assessment through the use of the *Performance Power* software. Gains were seen with this implementation. The gains were, however, somewhat inconsistent across grade levels and subject matter. In the second year of the intervention, an instructional component was added with the *A+dvanced Learning System (A+LS)*. With this addition, gains increased once again and the gains were more consistent.

At this point, it may be useful to speculate about the reasons the intervention worked. In the first year, the intervention was limited to assessment software in which the student received immediate results and feedback about their performance. Perhaps the mechanism at work was the immediate feedback. The result being that students tended to have better focused attention to the tasks at hand leading to improved performance. An alternative hypothesis is that the *Performance Power* software gave the students practice in working with the form of testing that is used on the Iowa Test of Basic Skills.

Another area for speculation is with regard to the differential results in 2002-2003. The computation and composite mathematics scores were strong, but the problem solving and concepts scores were weaker or nonsignificant. Perhaps the reason for this is that the intervention in the first year amounted to practice in answering test questions that focus on computation.

What happens if an instructional component is added?

As noted previously, *A+LS* was added in the second year of the intervention. This added an instructional component. The result was that the overall school performance at St. Pius V increased to a point above the national average in both mathematics and reading. The gains were consistent across grade levels and ITBS subtests. At this point, the reader should be reminded that the students at St. Pius V are largely English Language Learners from immigrant families in an inner city setting. This makes the fact that St. Pius V mathematics and reading scores are above national averages all the more remarkable. So, it appears that adding self-paced instruction along with practice assessment extends the learning of the student body as a whole.

Additionally, in the second year, the gains were significant in all areas of mathematics. It appears that the addition of the instructional component resulted in gains not only in computation but also in problem solving, data, and mathematic concepts. Why the more consistent gains in year two? Perhaps it has to do with the added language component that is inherent in the instructional component. As the students are taught, there certainly is instruction in the areas being tested, but there is also a broader exposure to the language of instruction.

#### *Recommendations for Further Research*

The current study strongly suggested that the addition of a computer laboratory intervention for mathematics that included *Performance Power* and *the A+dvanced Learning*

System had a positive effect on academic achievement at the St. Pius V Elementary School. However, certain limitations need to be mentioned that lead to recommendations for further research. Charitably, this study could be considered a nonequivalent control group design with the ITBS normative group as the control group. On the other hand, many will argue that this is not a control group at all and the study is merely a one group, pretest-posttest design (Campbell and Stanley, 1963). In either case, the design of this study does not completely eliminate alternative hypotheses for the growth seen on the ITBS scores.

As a result, one of two strategies can be taken to control for extraneous variables. The first option is to extend the study to schools with similar demographics and begin a study with a control group design and gather data from individual students. Individual student data would yield a much stronger study that examines individual student effects. However, at St. Pius V, there is already a strong feeling that these two interventions are making a substantial difference in the achievement of their students, so there may well be objections to control groups where the intervention is not used. The study may need to proceed at other locations.

Another way to overcome this objection is to use a time series design (Campbell and Stanley, 1963). In the current study, only three data points were used. Certainly, historical data could be gathered from earlier ITBS results to document achievement trends over a longer period of time. This would greatly enhance the ability to rule out alternative explanations from the current intervention.

Another area for further investigation is the nature of the student population at St. Pius V. As noted, the majority of the population is English Language Learners. The question that arises is whether this intervention would be as effective with inner city students who are English

speakers. The same question could also be asked about suburban English speakers and suburban English Language Learners.

A final area for consideration is the relation of this intervention at St. Pius V Catholic School and public education as a whole. Parochial education is often thought to be an advantage, but these advantages are probably more illusory than real. This very question was subjected to research in New York City (Mayer, Peterson, Myers, et al, 2002). This innovative study investigated, through random trials, the effects of private schooling on academic achievement. The finding showed that, overall, there was no advantage in academic performance as measured by test scores, to attending private schools. Really, educational performance is about the same in public and private schools. This study was followed with the investigation of a similar question in three additional cities (Howell, Wolf, Peterson, Campbell, 2000). The findings were the same. Private education did not lead to increases or decreases in academic performance when compared to local public schools. It is the opinion of these writers that the interventions investigated in this study are likely to be useful in both parochial and public education. Nevertheless, the means by which this can be determined is by further study.

### Summary and Conclusion

What has been found? The combination of *Performance Power* and the *A+dvanced Learning System* in a computer laboratory where the students attend three forty minute periods each week appear to have had a significant, if not a dramatic impact on the learning of the students at St. Pius V. In the two years that this program has been in place, this small, urban school whose students are mainly English Language Learners from immigrant families went from below the national average on the Iowa Test of Basic Skills to above the national average.

It appears that the combination of *Performance Power* and the *A+dvanced Learning System* provides a stronger and more consistent result than does the use of *Performance Power* alone.

Has it worked? Has it been worth the effort? Yes! It has worked. An obvious truism in education is where you devote attention, there you will see results. If you increase the time devoted to mathematics from five periods a week to eight – three additional periods of mathematics in the computer lab – you will get results.

Two students' stories should be told. At the present time, for example, there are two third graders at St. Pius V Elementary School who are now doing fifth grade mathematics on *A+LS* software in the computer lab. They have passed the entire fourth grade without ever having attended a fourth grade mathematics class with a fourth grade mathematics teacher. This is a progression to which there is no fixed limit. These two students are not just bright; they are brilliant. How many brilliant students are there in a school of 360? Could there be 20 or more? So much for the phalanx, the model in which all of the children march in locked step and progress at the same rate, everyone learning the same thing at the same time. If you have Achilles in your squadron, you don't line him up with the rank and file. It is a sound and logical expectation, and the privileged, private schools do this all the time. These two third graders will be doing Algebra I and Algebra II in the seventh grade. High School Geometry could come in the eighth grade. By the time they leave elementary school, calculus will be only a heartbeat away. It is the computer laboratory, with its capacity to provide self-paced learning in an environment where resources are scarce, that makes this possible.

If you'd like to come to the Wall of Honor and see for yourself the smiling faces of these double grade jumpers, come visit the website at <http://www.stpiusv.net/academ/GrdJmp/GJHome.htm>.

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Appendix A

Statistical Results

Analysis of Growth of ITBS Scores from 2002 to 2003\*

Grade	ITBS-Composite <i>t</i>	ITBS-Concepts <i>t</i>	ITBS-Problem Solving & Data <i>t</i>	ITBS-Computation <i>t</i>
2	54.86**	65.49**	14.88**	62.94**
3	25.03**	23.88**	4.62	47.75**
4	32.89**	-3.81	18.12**	49.10**
5	2.81	-0.70	-9.85**	20.05**
6	8.84**	0.63	-1.89	42.62**
7	3.42	0.00	0.00	-19.27**
School Average	123.53** eta <sup>2</sup> = .51***	88.86** eta <sup>2</sup> = .36***	22.61** eta <sup>2</sup> = .09***	186.74** eta <sup>2</sup> = .76***

\*All *t* scores were obtained using the following method.

$$t = \frac{(\bar{X}_1 - \bar{X}_2) - (\mu_1 - \mu_2)}{s_{\bar{X}_1 - \bar{X}_2}} \text{ where } s_{\bar{X}_1 - \bar{X}_2} = \sqrt{s^2 \left( \frac{1}{n_1} \right) \left( \frac{1}{n_2} \right)} \text{ Hinkel, et al, p 238-249}$$

\*\* Statistically significant difference with *p* < .01

\*\*\* eta<sup>2</sup> was calculated using the Hedges method for bias correction

Appendix B

Statistical Results

Analysis of Growth of ITBS Scores from 2003 to 2004\*

Grade	ITBS-Composite <i>t</i>	ITBS-Concepts <i>t</i>	ITBS-Problem Solving & Data <i>t</i>	ITBS-Computation <i>t</i>
2	-1.00	-25.38**	22.37**	5.68
3	14.81**	33.52**	32.35**	15.98**
4	24.41**	33.43**	26.67**	13.52**
5	1.20	9.18**	15.16**	-22.74**
6	23.32**	20.99**	27.21**	22.16**
7	10.25**	9.63**	7.77**	48.47**
8	23.80**	-12.42**	-3.45	24.83**
School Average	96.94** eta <sup>2</sup> = .38***	62.55** eta <sup>2</sup> = .24***	125.84** eta <sup>2</sup> = .49***	117.79** eta <sup>2</sup> = .46***

\*All *t* scores were obtained using the following method.

$$t = \frac{(\bar{X}_1 - \bar{X}_2) - (\mu_1 - \mu_2)}{s_{\bar{X}_1 - \bar{X}_2}} \text{ where } s_{\bar{X}_1 - \bar{X}_2} = \sqrt{s^2 \left( \frac{1}{n_1} \right) \left( \frac{1}{n_2} \right)} \text{ Hinkel, et al, p 238-249}$$

\*\* Statistically significant difference with  $p < .01$

\*\*\* eta<sup>2</sup> was calculated using the Hedges method for bias correction

Appendix C

St. Pius V Iowa Test of Basic Skills Normal Curve Equivalents for  
Mathematics Concepts Scores\*

Grade	Mathematics Concepts 3/2002	Mathematics Concepts 3/2003	Mathematics Concepts 3/2004
	39.31	72.23	55.99
2	50	37	30
	41.66	54.92	73.30
3	41	36	42
	38.67	36.96	55.99
4	58	39	36
	47.22	46.79	51.71
5	28	44	36
	44.01	44.44	55.99
6	32	32	47
	48.29	48.29	54.92
7	31	31	31
		52.78	45.08
8		32	38
School	43.19	50.92	56.14
Average	240	251	260

\* Top numbers are Normal Curve Equivalents, lower numbers are the number of students.

Appendix D

St. Pius V Iowa Test of Basic Skills Normal Curve Equivalents for Mathematics  
Problem Solving and Data Scores\*

Grade	Problem Solving & Data 3/2002	Problem Solving & Data 3/2003	Problem Solving & Data 3/2004
2	34.82 50	42.30 37	56.63 30
3	42.94 41	45.51 36	63.26 42
4	41.23 58	49.36 39	64.54 36
5	48.93 28	42.94 39	51.07 36
6	42.94 32	41.66 32	56.63 47
7	48.93 31	48.93 31	54.28 31
8		46.15 32	44.01 38
School Average	43.30 240	45.27 251	55.77 260

\*Top numbers are Normal Curve Equivalents, lower numbers are the number of students.

Appendix E

St. Pius V Iowa Test of Basic Skills Normal Curve Equivalents  
for Computation Scores

Grade	Mathematics Computation	Mathematics Computation	Mathematics Computation
	3/2002	3/2003	3/2004
2	50.00	81.64	85.28
	50	37	30
3	58.77	85.28	94.04
	41	36	42
4	55.56	77.58	85.28
	58	39	36
5	60.05	72.24	60.05
	28	44	36
6	31.19	60.05	72.24
	32	32	47
7	63.26	50.00	83.35
	31	31	31
8		58.77	74.16
		32	38
School Average	53.14	69.36	79.20
	240	251	260

\*Top numbers are Normal Curve Equivalents, lower numbers are the number of students.

Appendix F

St. Pius Iowa V Test of Basic Skills Normal Curve Equivalents for Mathematics Composite Scores

Grade	Mathematics Composite 2002	Mathematics Composite 2003	Mathematics Composite 2004
	37.60	65.18	64.54
2	50	37	30
	46.15	60.05	68.17
3	41	36	42
	38.03	52.78	66.68
4	58	39	36
	51.07	52.78	53.42
5	28	44	36
	41.23	47.22	60.05
6	32	32	47
	53.21	55.56	62.61
7	31	31	31
		53.42	68.17
8		32	38
School Average	44.55	55.28	63.38
	240	251	260

\*Top numbers are Normal Curve Equivalents, lower numbers are the number of students.

Appendix G

St. Pius V Iowa Test of Basic Skills Normal Curve Equivalents for Language Scores

Grade	ITBS Language 2002	ITBS Language 2003	ITBS Language 2004
2	34.25	45.74	62.34
	49	37	30
3	47.23	63.19	68.73
	41	36	42
4	44.04	57.24	80.00
	58	39	38
5	49.36	46.17	60.00
	28	44	37
6	44.47	52.34	54.26
	32	32	47
7	51.70	59.36	68.73
	31	31	32
8		57.02	58.72
		32	38
School Average	45.18	54.44	64.68
	239	251	254

\*Top numbers are Normal Curve Equivalents, lower numbers are the number of students.

Appendix H

Statistical Results

Grade	Analysis of Growth of ITBS Language Arts Scores from 2002 to 2003*		Analysis of Growth of ITBS Language Arts Scores from 2003 to 2004*	
	ITBS Reading Total <i>t</i>	ITBS Language Total <i>t</i>	ITBS Reading Total <i>t</i>	ITBS Language Total <i>t</i>
2	-0.85	22.94**	21.27**	25.93**
3	-11.12**	28.75**	14.35**	10.09**
4	3.80	29.42**	13.83**	41.10**
5	-25.56**	-5.25	21.33**	26.17**
6	-24.51**	11.63**	29.40**	3.48
7	10.21**	11.13**	-9.43**	13.83**
8			26.44**	2.78
School	-57.54**	106.59**	114.47**	123.64**
Average	eta <sup>2</sup> = -.28***	eta <sup>2</sup> =.43***	eta <sup>2</sup> =.44***	eta <sup>2</sup> =.48***

\*All *t* scores were obtained using the following method.

$$t = \frac{(\bar{X}_1 - \bar{X}_2) - (\mu_1 - \mu_2)}{s_{\bar{X}_1 - \bar{X}_2}} \text{ where } s_{\bar{X}_1 - \bar{X}_2} = \sqrt{s^2 \left( \frac{1}{n_1} \right) \left( \frac{1}{n_2} \right)} \text{ Hinkel, et al, p 238-249}$$

\*\* Statistically significant difference with *p* < .01

\*\*\* eta<sup>2</sup> was calculated using the Hedges method for bias correction