Pittsburgh Science & Technology

Dream. Discover. Design.

Process Summary

Pittsburgh Public Schools

May 29, 2008

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Introduction

The Pittsburgh Public School Board and Superintendent of Pittsburgh Public Schools Mr. Mark Roosevelt initiated *Excel.9-12: The Plan for High School Excellence*, part of a larger "Excellence for All" public school improvement agenda.

Recognizing the expanding economic and intellectual opportunities in science and technology fields the School Board and Superintendent made a commitment to opening a science and technology school. This school is part of the District's strategy to help students become "Promise Ready". A model for responsible public innovation, the school is designed to help each student plan and prepare for the unique financial aid opportunity provided by the Pittsburgh Promise[1] and/or the pursuit of a postsecondary opportunity of their choice.

This document summarizes the process that has been undertaken to create and implement the Pittsburgh Science and Technology proposal. It explains the demand for this school, providing evidence of the diverse set of stakeholders with an interest in seeing this program open in 2009 in Pittsburgh Public Schools. It explains the challenge that this school must be designed to overcome, a challenge that has been carefully defined through a significant body of primary and secondary research. It also explains the theory of how this program's five primary innovations and support systems are designed in order to address these critical challenges.

Many Pittsburghers have contributed to the detailed plan for the program. Identified in this document these individuals have given their time generously to the project. They have guided the determination of content to be offered, systems to be implemented, and innovations to be developed. They have helped make decisions and recommendations at critical junctures and brought many voices to the project. These individuals represent industry, university, community organizations, researchers, and, most importantly, the staff, parents, and students of Pittsburgh Public Schools.

Individual contributors to the project, those who have made a concrete recommendation or suggestion which became a part of the design have been identified whenever possible and this list included here as appendix to the document.

Also included in this document are the reports from focus groups, retreats, and community meetings as well as summaries of some of the outstanding science and technology schools (and other model public programs) which influenced and inspired. The task list which guides our process, the major accomplishments of each month of implementation, and a bibliography also contribute to this document.

[1] More information about the Pittsburgh Promise can be found online at www.pittsburghpromise.com.

Step 1: Understanding the Need for a STEM Program

The demand for stronger Science and Technology education spans all levels and sectors. Providing enhanced Science, Technology, Engineering, and Math (STEM) education is imperative in order to create more meaningful educational opportunities for Pittsburgh students, ensure regional growth and economic stability, and close the racial and gender gap that exists in STEM education.

The fact is that Pittsburgh wants this type of school. Parents want it for their children. Children want it for themselves. Regional employers and universities want it for their performance, and for their future. It is a critical part of preparing Pittsburgh Public School graduates to compete in the world and providing them with choices for their future.

Context

While the education system has remained static, the national economy has changed. Comprehensive urban high schools continue to prepare only a minority of students for continuing education or skills intensive employment despite the fact that deindustrialization, suburbanization, outsourcing, and the relocation of manufacturing jobs away from center cities have changed the American economy.[2] Jobs which remain accessible from the urban core now require higher levels of skill than they did when comprehensive urban high schools were designed. Unfortunately, education policy at all levels has been slow to adapt to this new economic situation.

It is no longer appropriate for the school to act as a "sorting mechanism", tracking only a select group of students toward college while leaving the majority to pursue limited low-skilled jobs that may fail to adequately support a family. As the Gates Foundation emphasizes, "Today's large, impersonal high schools were designed for a different era and a different economy."[3]

Citizens are understandably frustrated with the poor performance of urban public schools. However, the reality is that there has never been a time when all students graduated from high school, or even when the system achieved significantly better academic results than it does today. Joyce Baldwin argues that the problem in not that schools are suddenly failing, but rather that "most have *never* graduated more than fifty percent of students, or prepared more than a third of students for postsecondary education."[4] The same results simply *seem* worse today because the factory and other labor intensive industry jobs that used to be open to high school dropouts are no longer there in the same numbers.

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[2] Sugrue, T.J., *The Structures of Urban Poverty: The Reorganization of Space and Work in Three Periods of American History*. 86-117, The Underclass Debate, ed. Michael Katz (Princeton, NJ: Princeton University Press, 1993).

[3] *High Schools for the New Millennium*, Bill and Melinda Gates Foundation, Retrieved from http://www.gatesfoundation.org/UnitedStates/Education/TransformingHighSchools/default.htm (accessed September 15, 2006).

[4] Baldwin, J. (2001). Creating a New Vision of the Urban High School. Carnegie Corporation "Challenge" paper. New York, NY, Carnegie Corporation of New York**:** 14.

The problem is not that our education system has gotten worse. Rather, the primary problem is that public education, particularly urban public education, has failed to keep up with a changing society and economy.

At the same time, breakthrough schools across the United States demonstrate that public schools can modernize, and are capable of connecting students to relevant and competitive postsecondary opportunities. These schools, through commitment to clearly defined outcomes, innovation, high expectations, and excellent instruction are succeeding for all types of students, including those who enter school with significant academic deficits in core content areas.[5]

Neither Pittsburgh's economy nor its public school system is exempt from these challenges. Pittsburgh's comprehensive high schools do demonstrate pockets of success. Innovative teachers and administrators, and specific programs are successfully preparing students for success in a dynamic economic era. But despite these efforts most students are not leaving school prepared to succeed in a skills driven economy in which workers, managers, and leaders in all competitive industries are expected to learn on the job, shift positions, think critically, acquire new skills, and contribute to innovation.

Evidence of Demand

Demand for this program fits into several categories, spanning sectors and demographics and demonstrating clearly that there is demand in this region for a forward thinking STEM program.

There are five primary reasons why the implementation of a cutting edge, science and technology focused school is the right decision for the city of Pittsburgh, and an appropriate response to the challenge facing public education in the city.

- **Students and families** want new educational options and demonstrate interest in STEM opportunities;
- **Universities and employers** want graduates prepared to meet their expectations;
- **Our region** wants students prepared for expanding STEM opportunities.
- **Our society** wants more scientifically literate citizens.
- **Female students and students of color** want and deserve equal access to STEM opportunities.

Other districts in the region are recognizing this demand and providing an opportunity for students to perform research and explore STEM fields. On April 4th and 5th the Pittsburgh Regional Science and Engineering Fair was held at Heinz Field. More than 1000 projects from 23 counties in Western Pennsylvania were displayed and $750,000 in prizes and scholarships were awarded in at least 21 categories. There were only 36 entries from all of Pittsburgh Public Schools, the largest District in the region. One PPS student earned a second place award and another earned an honorable mention.

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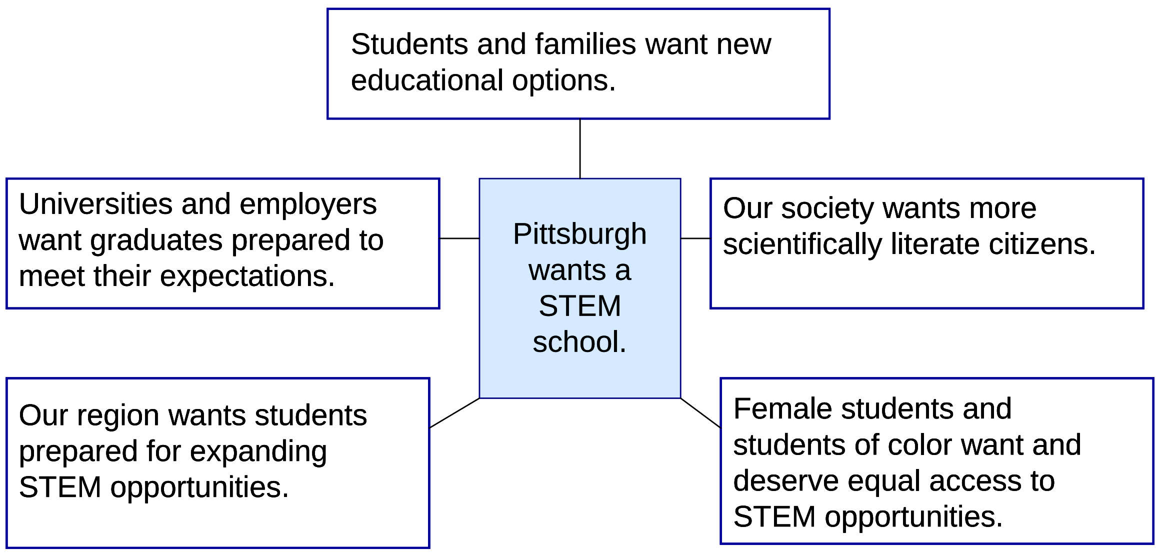
[5] NASSP, N. A. o. S. S. P. (2006). "Breakthrough High Schools." Retrieved November 10, 2006, from http://www.principals.org/s_nassp/sec.asp?CID=66&DID=66.

Surely there are dozens of PPS students who are talented scientists, mathematicians, engineers, researchers, innovators, and technologists. Some of them know it now and others have potential that they may not even recognize. These students need a place to develop their abilities, a place where they can shine.

Figure 1: Demand for a STEM focused school fits into five categories, demonstrating that a theme-based school is right for the city of Pittsburgh.



1. Students and families want more and better educational options.

Pittsburgh Science and Technology is one of many necessary new options in a larger reform movement designed to provide working options for families not adequately served by the current system. Evidence demonstrates the need for a range of new opportunities.

Pittsburgh families are demonstrating their demand for new programs in several ways. They are seeking out special programs within the public school system, enrolling in magnet options, choosing to attend charter schools, or deciding to exit the system all together if they have the means to do so.

In Pittsburgh, too many students are opting out of the public school system. At least 27% of the city's high school age students attend a private, parochial, or charter school rather than a Pittsburgh public school.[6] Additionally, too many students are "zoning out." Of the students who do attend a Pittsburgh public school, and do make it to the eleventh grade, 49% are not proficient in reading and 60% are not proficient in math.[7]

[6] Roosevelt, M. (2006). Excellence For All: A Four-Year Comprehensive Framework for Improvement.
[7] GreatSchools.net. (2006, 2006). "Pittsburgh School District." Retrieved November 12, 2006, 2006, from http://www.greatschools.net/cgi-bin/pa/district_profile/401/.

Finally, too many students drop out of school altogether. An estimated 36 percent of students do not graduate from high school within *five years* of starting ninth grade.[8]

2. Universities and employers want students prepared to meet their expectations.

Between 2000 and 2015, the Workforce Readiness Project estimates that about 85 percent of newly created U.S. jobs will require education beyond high school.[9] Thus, it is no longer acceptable for high schools to track a minority of students through a "college preparation" program while expecting that the majority of students taking the non-college track will find living wage opportunities in low skill industries.

All graduates of Pittsburgh Public Schools should be prepared to access and succeed in higher education if they choose to pursue this opportunity. Whether graduates attend four year institutions or pursue other reasonable educational options such as a trade or technical school, a certification program, or a community college, modern high schools must respond to economic realities by accepting a new level of academic responsibility.

Unfortunately, current comprehensive high schools were not designed to prepare all students for skilled employment or continuing education. The majority of students graduating from U.S. high schools do not have the academic skills necessary to succeed in higher education. In 2002, only 34 percent of graduates were considered to be adequately prepared for college.[10]

Employers and workforce development organizations demonstrate their desire for improved STEM education by organizing and attending conferences, producing reports, pressuring public officials to make STEM education a priority, and by producing research which highlights the gap that exists between the expectations of public schools and the needs of 21st century employers.[11]

The lack of alignment between the expectations of public education and those of 21st century employers and universities costs organizations, students, and families. "Higher education institutions, businesses, and students and families themselves are spending upward of $17 billion each year on remedial classes just so students can gain the knowledge and skills that they should have acquired in high school."[12]

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[8] Engberg, J. & Gill, B., (2006). "Estimating Graduation and Dropout Rates with Longitudinal Data: A Case Study in the Pittsburgh Public Schools." RAND Corporation, RAND Education Working Paper Series, WR-372-PPS, Retrieved July 31, 2007, from http://www.rand.org/pubs/working_papers/2006/RAND_WR372.pdf.

[9] Casner-Lotto, J., L. Barrington, et al. (2006). Are They Really Ready To Work? Employers' Perspectives on the Basic Knowledge and Applied Skills of New Entrants to the 21st Century U.S. Workforce. Workforce Readiness Project Team. I. The Conference Board. The Conference Board, Inc.**:** 64.

[10] Greene, J. P. and M. A. Winters (2005). Public High School Graduation and College-Readiness Rates: 1991-2002. Education Working Paper. New York, NY, Manhattan Institute for Policy Research. **8:** 36.

[11] (2006). Closing the Expectations Gap 2006: An Annual 50-State Progress Report on the Alignment of High School Policies with the Demands of College and Work. Washington, D.C., Achieve, Inc. **:** 32.

[12] (2006). Closing the Expectations Gap 2006: An Annual 50-State Progress Report on the Alignment of High School Policies with the Demands of College and Work. Washington, D.C., Achieve, Inc. **:** 32.

3. The region wants students prepared for STEM opportunities.

The Three Rivers Workforce Investment Board used statistics from the Pennsylvania Department of Labor and Industry's Center for Workforce Information and Analysis to compile a list of "High Priority Occupations" in the Pittsburgh region. This list quantifies the anticipated growth of specific occupations between 2004 and 2014.[13]

There is significant regional growth anticipated in competitive science and technology industries. These skill driven professions generally have above average annual salaries and include opportunities for professional advancement.

Figure 2: The charts below identify the highest growth professions in Western PA that most directly involve application of science or technology knowledge.

Life, Medical, and Environmental Sciences	Percent Growth 2004-14
Emergency Medical Technicians and Paramedics	16.1
Biomedical Engineers	15.4
Medical Assistants	15.2
Environmental Engineers	14.8
Diagnostic Medical Sonographers	12.2
Biochemists & Biophysicists	10
Licensed Practical & Licensed Vocational Nurses	9.5
Veterinarians	7.1

Information Technology and Computer Science	Percent Growth 2004-14
Network Systems and Data Communications Analysts	37.3
Computer Software Engineers, Systems Software	33.3
Computer Software Engineers, Applications	28.2
Network and Computer Systems Administrators	15.9
Computer Systems Analysts	13.9
Computer and Information Scientists, Research	12.5
IT Managers – Programming, Network, and Database	8.1
Desktop Publishers	7.1

In addition to these projected growth figures in industries with a primary emphasis on science or technology, many growth professions that are not directly driven by science and technology require increasingly high levels of technology skills and scientific thinking capabilities. A vital requirement for students who will enter the work force is a firm foundation in science and technology, which is necessary not only for individual success, but for our region and country to establish strong economic growth.[14] The acquisition of scientific thinking skills, and the logical and mathematical thought

[13] TRWIB (2007). 2007 High Priority Occupations for Three Rivers Workforce Investment Area. Microsoft Excel. 2007ThreeRiversHPO-Final.pdf. Pittsburgh, Three Rivers Workforce Investment Board**:** Labor market information based on list compiled by the Pennsylvania Department of Labor and Industry's Center for Workforce Information and Analysis.

[14] Matthews, Christine M.. "Science, Engineering, and Mathematics Education: Status and Issues." 23 April 2007. Congressional Research Service. 27 Sep 2007 >http://digitalcommons.ilr.cornell.edu/cgi/viewcontent.cgi?article=1036&context=crs:> 7.

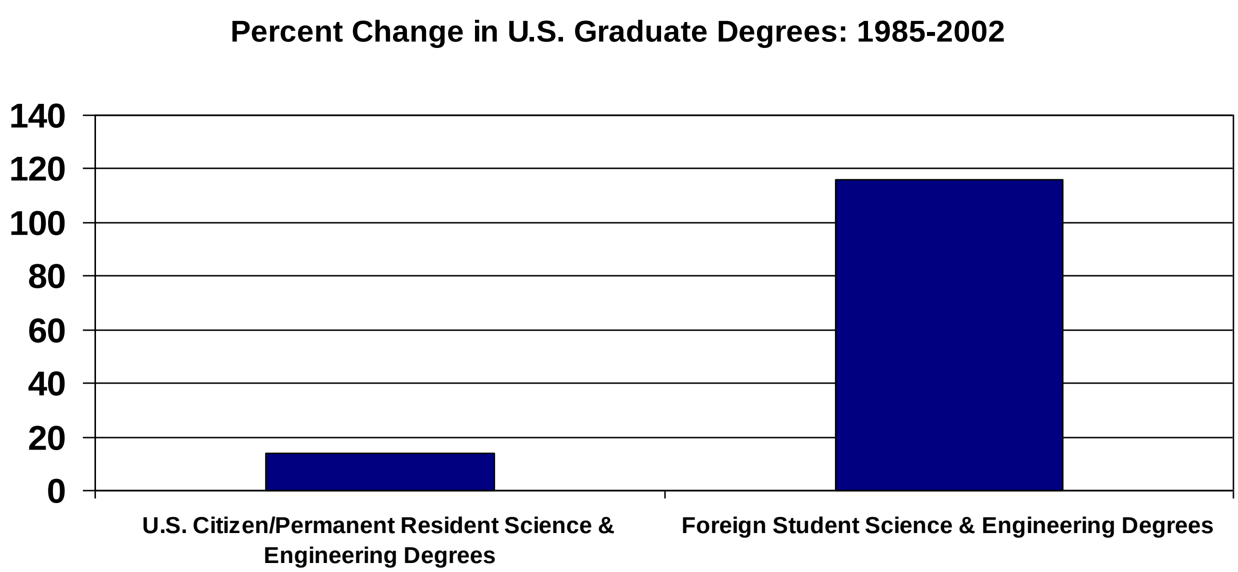
processes necessary to master the use of technology tools will benefit all students, even those who do not have a desire to enter science or technology fields,

4. Our society wants more scientifically literate people.

The United States is struggling to keep up with other nations in science, mathematics, and technology fields. Other nations are producing more college and graduate degrees measured in absolute terms and by percentage of overall degrees or total population. As a result, the U.S. is increasingly reliant on importing scientists, mathematicians, and engineers. Twenty-eight countries now have a higher percentage of 24 year olds with a math or science degree.[15]

The lower percentage of young adults with a science or math degree is predicated by the average level of proficiency shown by students on standardized tests in these fields. The Trends in International Mathematics and Science Study (TIMSS) in 2003 showed that US students are now being outperformed by students in many Pacific Rim nations and by schools in England and France.[16]

Figure 3: While the number of U.S. graduate degrees awarded to U.S. citizens in science and engineering fields increased less than 20%, the number of science and engineering graduate degrees awarded to foreign students more than doubled.



A general increase in the number of U.S. citizens pursuing graduate degrees has not been matched in science, technology, and mathematics (STEM) fields. While total U.S.

[15] Atkinson, R. D., J. Hugo, et al. (2007). Addressing the STEM Challenge by Expanding Specialty Math and Science High Schools. Washington, DC, The Information Technology & Innovation Foundation: 13.
[16] Matthews 21-22.

citizen non-science and engineering graduate degrees increased 64 percent between 1985 and 2002, graduate degrees in STEM fields awarded to U.S. citizens increased by just 14%. At the same time “degrees in STEM fields awarded to foreign-born students more than doubled.”[17]

In some fields there has been an absolute decline in the number of degrees awarded. Bachelor's degrees in engineering granted to Americans peaked in 1985 and are now 23% below that level. In 2000, over half of all Ph.D. scientists under age 45 were foreign born, up from 27% in 1990.[18]

Atkinson and Huge et al. argue that the wide range of policy solutions aimed at closing the STEM gap have largely ignored the potential impact that specialty math and science high schools can have in addressing this national challenge.[19]

5. Female students and students of color want and deserve equal STEM opportunities.

According to the National Science Board, African-Americans, Hispanics, and American Indians are less likely to take advanced courses in math and science in high school. Moreover, it is far less common for these groups to earn their college degrees or work in the science and technology fields in comparison to their white counterparts.[20]

African-Americans, Hispanics, and Native Americans form 25% of the US population, yet earn 16.2% of Bachelors degrees, 10.7% of Masters degrees, and 5.4% of Doctorate degrees in the fields of science and engineering.[21] Additionally, according to the National Science Foundation, out of all employed scientists and engineers, 75.2% are white, while only 8.9% are African-American, Hispanic, or American Indian.[22]

African American students make up 60.6% of the Pittsburgh Public Schools' population.[23] African American students in Pittsburgh will only have equal access to opportunities in high paying, competitive science and technology fields if public schools succeed in creating inclusive science and technology programs that move all students to success in advanced coursework.

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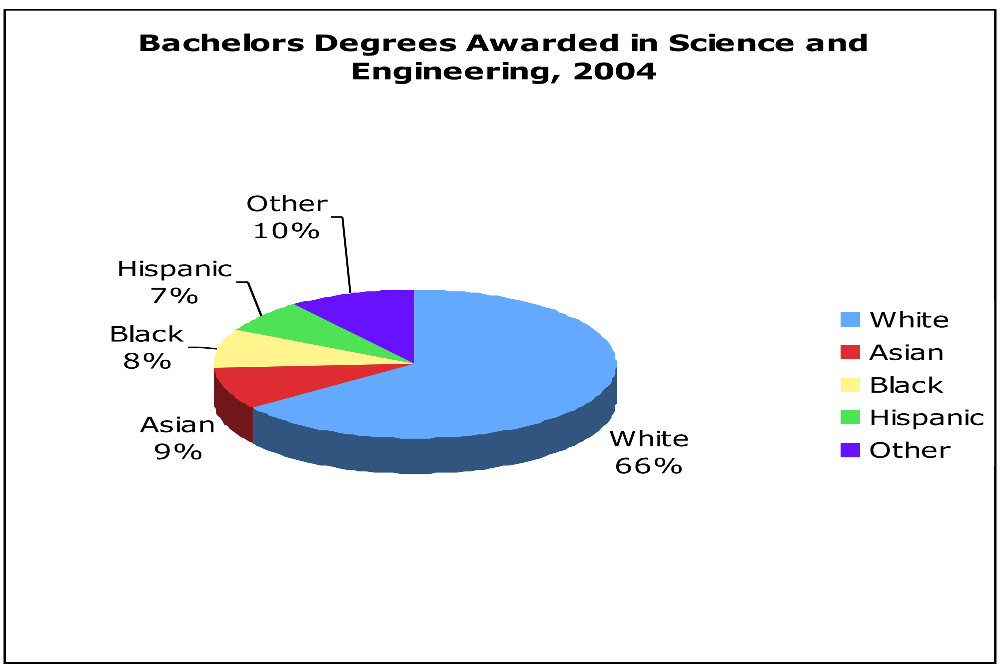
[17] Ibid.
[18] Atkinson, R. D., J. Hugo, et al. (2007). Addressing the STEM Challenge by Expanding Specialty Math and Science High Schools. Washington, DC, The Information Technology & Innovation Foundation**:** 13.
[19] Ibid.
[20] National Science Board, *Science and Engineering Indicators 2006, Volume 1*, pp. 3.18 - 3-22.
[21] Ibid. *Volume 2*, , Appendix Tables 2-27, 2-29, and 2-31.
[22] National Science Foundation, *Women, Minorities, and Persons with Disabilities in Science and Engineering, Table H-6.* < http://www.nsf.gov/statistics/wmpd/pdf/tabh-6.pdf>
[23] (2007). "Public School Profiles: Pittsburgh." Pittsburgh Business Times(Pittsburgh Business Times' Guide to Western Pennsylvania Schools): 1.

Many factors exist in the public education system that leads to the under representation of minorities in the science and technology field. Common factors include:

- Understaffed and under-equipped schools;
- Judgments about ability;
- Number and quality of science and mathematics courses offered;
- Access to qualified teachers;
- Access to resources; and
- Curricular emphasis[24]

A specialized science and technology school with an inclusive, outreach driven admissions process can be a first step in addressing these limiting factors. Through providing access to engaging courses in STEM subject areas students develop a desire to go deeper into these fields.

Figure 4: White students received 66% of the bachelor's degrees awarded to U.S. citizens in science and engineering in 2004.



Women have made significant strides in closing the representation gap in many STEM fields but remain significantly underrepresented in others.

> In 2004, women earned 58 percent of all bachelor's degrees, 78 percent of bachelor's degrees in psychology, 62 percent in biological sciences, 51 percent in chemistry, 46 percent in mathematics, 25 percent in computer

[24] Clark, Julia. "Minorities in Science and Math." May 1999. Eric Digest. 28 Sep 2007. <http://www.ericdigests.org/2000-2/minorities.htm>

> sciences, 22 percent in physics, and 21 percent in engineering. In general, women earn substantial proportions of the bachelor's degrees in math and the sciences, *except* in computer sciences, physics, and engineering.[25]

The root of underrepresentation in careers in physical sciences, physics, and certain other STEM fields seems to start after elementary school, when girls consistently demonstrate less confidence in their science and math abilities than boys and show less interest in science and math careers from early adolescence. Improving this self-image could make a major difference since girls who do show confidence and interest are more likely to choose STEM majors or careers.[26]

"The Girl Solution, A Gender Equity Toolkit" produced by The Girls, Math and Science Partnership suggests nine techniques for sparking girls' interest and raising their confidence in science and math.[27] A specialized STEM school can provide a safe space for girls to explore these fields and develop their abilities with confidence.

Conclusion

The diverse facets of demand for a specialized STEM program support the decision to open a cutting edge, science, technology, engineering, and math focused high school in Pittsburgh.

In order to maximize its impact on the challenges described in this document, the school should be an inclusive institution with an outreach component that attracts students of all races and socioeconomic circumstances. It should prepare all students for success in higher education and seek to send at least 85% of graduates directly into a two or four year educational opportunity.

Pittsburgh Science and Technology should include STEM concentrations that are aligned with regional economic growth expectations but it should also teach skills that are transferable to other areas. It should carefully balance the need to develop specific skills with a curriculum that provides a broad foundation in the thinking, learning, communications, and computational skills necessary for success in the 21st century.

Sam Franklin, 2008

[25] Halpern, D. F., J. Aronson, et al. (2007). Encouraging Girls in Math and Science. U. S. D. o. Education. Washington D.C., National Center for Education Research, Institute of Education Sciences: 55.
[26] Ibid.
[27] (2007). the girl solution. Pittsburgh, PA, Girls, Math & Science Partnership

(2006). Closing the Expectations Gap 2006: An Annual 50-State Progress Report on the Alignment of High School Policies with the Demands of College and Work. Washington, D.C., Achieve, Inc. **:** 32.

(2007). "Public School Profiles: Pittsburgh." Pittsburgh Business Times(Pittsburgh Business Times' Guide to Western Pennsylvania Schools): 1.

Atkinson, R. D., J. Hugo, et al. (2007). Addressing the STEM Challenge by Expanding Specialty Math and Science High Schools. Washington, DC, The Information Technology & Innovation Foundation**:** 13.

Baldwin, J. (2001). Creating a New Vision of the Urban High School. Carnegie Corporation "Challenge" paper. New York, NY, Carnegie Corporation of New York**:** 14.

Casner-Lotto, J., L. Barrington, et al. (2006). Are They Really Ready To Work? Employers' Perspectives on the Basic Knowledge and Applied Skills of New Entrants to the 21st Century U.S. Workforce. Workforce Readiness Project Team. I. The Conference Board. The Conference Board, Inc.**:** 64.

GreatSchools.net. (2006, 2006). "Pittsburgh School District." Retrieved November 12, 2006, 2006, from http://www.greatschools.net/cgi-bin/pa/district_profile/401/.

Greene, J. P. and M. A. Winters (2005). Public High School Graduation and College-Readiness Rates: 1991-2002. Education Working Paper. New York, NY, Manhattan Institute for Policy Research. **8:** 36.

NASSP, N. A. o. S. S. P. (2006). "Breakthrough High Schools." Retrieved November 10, 2006, from http://www.principals.org/s_nassp/sec.asp?CID=66&DID=66.

Roosevelt, M. (2006). Excellence For All: A Four-Year Comprehensive Framework for Improvement.

TRWIB (2007). 2007 High Priority Occupations for Three Rivers Workforce Investment Area. Microsoft Excel. 2007ThreeRiversHPO-Final.pdf. Pittsburgh, Three Rivers Workforce Investment Board**:** Labor market information based on list compiled by the Pennsylvania Department of Labor and Industry's Center for Workforce Information and Analysis.

Step 2: Understanding the Challenge Facing a New School

Comprehensive public schools have failed to keep up with a changing society and economy. The last one hundred years of education reform has been characterized by "tinkering" rather than by fundamental change.[28] Yet the national and regional economy that current high school graduates enter is very different from the economy of thirty or sixty or one hundred years ago.

It is no longer appropriate for the school to act as a "sorting mechanism" that tracks one group of students toward college and into skilled professions, while leaving the majority to pursue low-skilled, low-paying, and often inaccessible jobs.

But how does this macro level policy problem actually appear in schools? What specific challenges face a school that hopes to modernize its structures? What challenges must be overcome if a school hopes to succeed for *all* students?

Beginning in 2006, a team of Pittsburgh's community leaders, parents, educators, and experts began working together to improve secondary education in the city. This High School Reform Task Force identified five essential characteristics of successful secondary schools. These characteristics are identified in the graphic below.

Figure 1: Pittsburgh's High School Reform Task Force identified five core principles, essential characteristics of successful secondary schools.

SAFE & WELCOMING SCHOOL	*School is a physically and emotionally safe place that supports learning*
RELATIONSHIPS	*Personalized learning environment and connections to teachers, peers, and the school*
RIGOR	*High academic expectations for all students; engaging and demanding content and teaching*
STUDENT SUPPORT	*Special help to keep students on track*
RELEVANCE	*Prepare and connect students to the real world*

Unfortunately, current comprehensive high schools were not designed to achieve these principles. Therefore, realizing them requires more than tinkering. It requires a thorough understanding of each of these five challenges and an awareness of other challenges facing the system. Ultimately it requires the design of an innovative organizational structure, curriculum, and integrated set of systems.

[28] Tyack, D. B. and L. Cuban (1995). Tinkering toward utopia : a century of public school reform. Cambridge, Mass., Harvard University Press.

Drawing from a series of MDRC (www.mdrc.org) evaluations, Janet Quint also identified five challenges facing urban schools.[29] Her findings are compatible with those defined by the high school reform task force. As a result, the language she used to define these challenges, somewhat modified, has been combined with the language of the high school reform task force to form the section headings that follow.

Challenge # 1: A Safe and Welcoming School

Creating an orderly learning environment

An orderly environment does not mean a building full of silent classrooms and quiet workers. Although discipline, supported by rules and consistently enforced consequences, is a critical piece of this challenge, it is only the beginning.[30] An orderly environment is a safe space defined by consistently positive interactions, sustained relationships, and high expectations for both behavior and productivity. An orderly environment must mean a community united around a set of core values or "guiding principles" and working towards a common goal.[31]

Creating this type of environment can be difficult. Inconsistent discipline and poor behavior is an unfortunate reality in many urban high schools, undermining instruction and contributing to teacher frustration and turnover.

Discipline is not a new challenge for public schools, and even the many schools that have succeeded at creating a safe and welcoming environment have a hard time overcoming the public perception that they are disorderly and unsafe. Public surveys ranked "discipline" as the biggest problem facing public schools sixteen times between 1960 and 1988. It was in the top five every year.[32]

Challenge #2: Relationships

Creating a personalized learning environment

The importance of positive relationships between students and teachers cannot be underestimated. A broad range of reports and reform strategies agree on the fundamental

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[29] Quint, J. (2006). Meeting Five Critical Challenges of High School Reform: Lessons From Research on Three Reform Models. New York, NY, MDRC**:** 89.
[30] (2006). Classroom Management & Culture. New York, NY, Teach For America**:** 88.
[31] Daggett, W. R. (2004). America's Most Successful High Schools: Case Studies and Resources on Best Practices. Rexford, NY, International Center for Leadership in Education**:** 392.
[32] Tyack, D. B. and L. Cuban (1995). Tinkering toward utopia : a century of public school reform. Cambridge, Mass., Harvard University Press.

importance of positive teacher-student relationships.[33] But, as Lambert and Lowry explain, successful personalization means more than just positive student-teacher relationships. True personalization means that relationships develop to the point that instruction is tailored to the needs of individual students. Mutual trust grants teachers the "moral authority" to demand high performance,[34] and relationships are allowed to develop over time.[35]

Traditional high school structures do not support this level of relationship formation. In fact, "the organizational structure often gets in the way of teachers knowing and caring about students."[36] Large schools that move students swiftly from class to class and often leave teachers responsible for 150 students per day make it very difficult for students and adults to establish and maintain positive relationships. Often teachers know little more about their students than their names.

Moreover, the traditional school structure often places the subject, rather than the student, at the center of the experience. Teachers' jobs are structured in a way that encourages them to focus on communicating information universally rather than on guiding students through individualized educational processes. They are more likely to communicate with other teachers who teach the same subject rather than teachers who share the same students. They do not have time built into their schedules to call parents or work with students individually.

Challenge #3: Rigor

Improving instructional content and practice; and

Challenge #4: Relevance

Connecting education to the world beyond high school

These challenges should be addressed together because one cannot work without the other. A rigorous program that is not relevant to students' lives, one that fails to connect to students' personal interests, to their community and environment, and to economic opportunity, will leave them disengaged and apathetic. Similarly, a program that has relevance but lacks rigor will set students up for frustration, and potentially for failure, when they finish the program and struggle to meet the expectations of higher education or the workplace.

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[33] Lee, V. E. and D. T. Burkam (2000). Dropping Out of High School: The Role of School Organization and Structure. "Dropouts in America: How severe is the problem? What do we know about intervention and prevention?" Harvard Graduate School of Education, Cambridge, MA, University of Michigan.
[34] Lambert, M. B., L. K. Lowry, et al. (2004). Knowing and Being Known: Personalization as a Foundation for Student Learning. Seattle, WA, Center on Reinventing Public Education, University of Washington**:** 43.
[35] Darling-Hammond, L. (2002). Redesigning Schools: 10 Features of Effective Design. Stanford, CA, School Redesign Network, Stanford University**:** 75.
[36] Lambert, M. B., L. K. Lowry, et al. (2004). Knowing and Being Known: Personalization as a Foundation for Student Learning. Seattle, WA, Center on Reinventing Public Education, University of Washington**:** 43.

Traditionally, both relevance and rigor have been unevenly distributed. Expectations for students and the content, quality and organization of lessons tend to vary widely from one classroom to the next.[37] Establishing consistent, high quality instruction is perhaps the most difficult, and most important, challenge facing an urban public high school. Also challenging is making education relevant on two important levels: (1) ensuring that it is adaptable to the interests and skills of each student while (2) connecting it to the issues, needs, and realities of life beyond the school walls.

Secondary curricula often induce disengagement and apathy. Technology tools are a daily reality for this generation of students. Yet despite the efforts of "techno-promoters" very few teachers are using technology to change the nature of instruction.[38] Disconnected, subject-specific instruction fails to teach the connections that exist between subjects. There is little capacity to address the needs, interests, and development of students as individuals. In this context it should not be surprising that there are low graduation and proficiency rates in key subject areas, [39] and that two-thirds of high school students said "they could do better if they tried," and half of students considered school "boring and too easy."[40]

Engaging students in advanced mathematics, science, and technology education is particularly challenging. Despite expert opinion that math, science and technology are critical to the nation's economic future, most students do not view these subjects as important for themselves. This fact is demonstrated by a 2007 survey of parents and students in Kansas and Missouri which concluded that,

> "…while parents and students have a measure of appreciation for the role science, math and technology will play in the future world of work, this appreciation remains thin, and relatively few seem to absorb the implications in a personal sense. Most parents do not see improving math, science and technology education as a top challenge facing their local schools, and most students do not come to these subjects with a strong sense of motivation and interest".[41]

In summary, large, anonymous urban high schools have a hard time increasing the level and quality of instruction while linking education to "life beyond the walls of the classroom."[42] Together, the lack of relevance and lack of rigor has created an

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[37] Darling-Hammond, L. (2002). Redesigning Schools: 10 Features of Effective Design. Stanford, CA, School Redesign Network, Stanford University**:** 75.
[38] Peck, C., L. Cuban, et al. (2002). "Techno-Promoter Dreams, Student Realities." Kappan Professional Journal.
[39] RAND. (2002).
[40] Johnson, J. and S. Farkas (1997). What American Teenagers Really Think About Their Schools. New York, NY, Public Agenda**:** 56.
[41] Kadlec, A. and W. Friedman (2007). Important, but Not for Me: Parents and Student in Kansas and Missouri Talk About Math, Science, and Technology Education. New York, NY, Public Agenda**:** 28.
[42] Legters, N. E., J. M. McPartland, et al. (2004). Scaling Up Talent Development High Schools: Lessons Learned From Comprehensive High School Reform. Expanding the reach of education reforms : perspectives from leaders in the scale-up of educational interventions. T. K. Glennan and Rand Education (Institute). Santa Monica, CA, RAND**:** 379-431.

"expectations gap," i.e. a disjunction between the expectations of high schools and demands of employers and postsecondary educational institutions.[43]
In response to these challenges districts are rethinking the structure of their schools. Districts, schools, and progressive teachers are beginning to rethink not only what they teach but also how they teach. High school curricula are increasingly designed to have more relevance to student interests and adaptability to student needs. This is particularly important when dealing with fields that students tend to approach with a certain level of skepticism or disinterest. It is necessary, but not easy, to help students understand why math, science, and technology courses are relevant, and demonstrate that work in these fields can be fun, creative, and rewarding.

Challenge #5: Student support

Assisting students who enter high school with poor academic skills

Most students enter public high school with below grade-level academic skills. The past four cycles of the National Assessment of Educational Progress (NAEP) show that the total percentage of eighth graders scoring at or above the "proficient" level in mathematics is lower than 30 percent.[44] According to the 2005-2006 PSSA test, 58 percent of Pittsburgh eighth graders are at or above the proficient level in Reading and 46 percent have demonstrated or surpassed proficiency in Math.[45] Adding to the alarming nature of these percentages is that they measure how well students are mastering grade-level appropriate skills as defined by Pennsylvania state standards; standards which remain low relative to other states and are yet to be aligned with the expectations of the 21st century workplace.[46]

A new school must be prepared to assist students who enter high school with poor academic skills. Traditional high school structures do not meet this challenge. Instead, students who enter school with poor academic skills are tracked into "watered-down" academic courses. The number of students achieving at grade level actually decreases throughout high school even as a significant number drop out. In Pittsburgh, by the time students are in 11th grade, only 51 percent are scoring at or above proficient in Reading, and only 40 percent in Math.[47]

Furthermore, the pressure to teach state standards and meet Annual Yearly Progress measures established by No Child Left Behind often leaves teachers reluctant to divert time from teaching grade level standards. There is little time to focus on intervention and

[43] (2006). Closing the Expectations Gap 2006: An Annual 50-State Progress Report on the Alignment of High School Policies with the Demands of College and Work. Washington, D.C., Achieve, Inc. **:** 32.
[44] (2006). Improving Math Performance. Seattle, WA, Bill & Melinda Gates Foundation**:** 6.
[45] GreatSchools.net. (2006, 2006). "Pittsburgh School District." Retrieved November 12, 2006, 2006, from http://www.greatschools.net/cgi-bin/pa/district_profile/401/.
[46] (2006). Closing the Expectations Gap 2006: An Annual 50-State Progress Report on the Alignment of High School Policies with the Demands of College and Work. Washington, D.C., Achieve, Inc. **:** 32.
[47] GreatSchools.net. (2006, 2006). "Pittsburgh School District." Retrieved November 12, 2006, 2006, from http://www.greatschools.net/cgi-bin/pa/district_profile/401/.

remediation for students who are falling (or remaining) behind. Building time for support into already strained schedules is not easy and requires a willingness to make sacrifices in other areas.

Additional Challenges

Five additional challenges also need to be addressed. Each falls within the larger framework outlined above but should be explicitly identified. These challenges are: (1) Closing the racial achievement gap; (2) Solving the social promotion/retention conundrum; (3) Providing the extra support and special attention required in transition years; (4) Overcoming poor completion and graduation rates; and (5) Ensuring access to and success in advanced coursework.

1. Closing the racial achievement gap

Although approximately 50 percent of the school age population in Pittsburgh was white in the 2000 census[48], African American students make up more than sixty percent of the Pittsburgh public school population, outnumbering white students by more than 6,000.[49]

Achievement data indicates a significant racial achievement gap. 77 percent of white eighth graders scored at or above proficient on the PSSA, but only 45 percent of African Americans scored as high. In math, 33 percent of Black students scored proficient or above, while 64 percent of white students reached this threshold.[50] Unequal distribution of resources often contributes to this gap. For example, in Pittsburgh, African American students are less likely to have experienced teachers with Master's degrees.[51]

Superintendent Mark Roosevelt has made closing the racial achievement gap a priority. According to the Pittsburgh Post-Gazette, Mr. Roosevelt's goal is to increase minority students' test scores at a rate of 5 percentage points higher than those of white students, "so that the races' proficiency levels will converge in 10 to 15 years."[52]

Examples of successful schools from around the country clearly demonstrate that African American students are capable of high academic achievement and postsecondary success, even when entering high school below grade level. Despite the persistence of certain racist opinions we also know for certain that students of color are equally intelligent and as capable of learning as white students. Finally, history demonstrates that African

[48] PPS. (2006). "Pittsburgh Public Schools 2005 Atlas & Data Analysis." Retrieved November 12, 2006, 2006, from http://visc.sis.pitt.edu/pps/2005Atlas/atlas.htm.
[49] (2007). "Public School Profiles: Pittsburgh." Pittsburgh Business Times(Pittsburgh Business Times' Guide to Western Pennsylvania Schools): 1.
[50] These numbers are slightly different depending on the source and year. The numbers cited are from GreatSchools.net's analysis of the 2005-06 PSSA scores. Numbers from other reports are slightly lower in all categories.
[51] Beam, J. M. and G. Eddins (2003). Poverty, Race, Resources, Results in the Pittsburgh Public Schools. New York, NY, National Center for Schools and Communities, Fordham University**:** 19.
[52] Smydo, J. (2006). Pittsburgh school chief sets big goals for district. Pittsburgh Post-Gazette. Pittsburgh.

American families have strived determinedly to overcome significant and oppressive barriers in order to access educational opportunities in the United States. Given these certain truths the existence of this persistent achievement gap is unacceptable.

Despite the success of exceptional students, teachers, and schools it must finally be honestly acknowledged that, *as a whole*, the current system is not designed to close this gap and is not capable of doing so. Consider for the purpose of explanation two equally capable runners training for a race. If one has been training for years, and the other is only getting started, it would be silly to think that the second runner could close the gap if they both train for the same amount of time and with the same exercises each day. In order to catch up the second runner must train more than the first if they wish to truly close the gap. Yet our system does not accommodate this type of differentiation. We expect that all students will graduate after four years, regardless of their academic level, rather than allowing for flexible programs that would allow any student to design a purposefully extended program that would give them more time to reach a certain advanced academic standard.

Even if the system was changed to accommodate this type of differentiated program design it would not necessarily be enough to close the gap. Successfully holding all students to the same high expectations requires helping teachers and administrators overcome biases that they may not even be aware of.

Furthermore, many students of color have had school experiences that "undermine their self confidence and their conception of their own ability to succeed."[53] The school must create an environment that is multicultural, explicitly anti-racist, is culturally responsive, and does not shy away from issues of race or color.[54] This requires a mature and educated staff and leaders that are capable of leading this process.

2. Solving the social promotion/retention conundrum

In our "age-graded" school system there are two alternatives for addressing the needs of students who do not meet expected achievement standards. Unfortunately neither retention nor social promotion actually helps a student who is not succeeding academically. Neither one of these options addresses student achievement, contributes to closing the achievement gap, or reduces dropout rates.[55] A new urban school should break out of the traditional age graded system that leaves administrators and teachers with these two unfortunate choices. But despite this flaw in the age-graded system there is a lack of proven alternatives.

[53] Darling-Hammond, L. (2002). Redesigning Schools: 10 Features of Effective Design. Stanford, CA, School Redesign Network, Stanford University**:** 75.
[54] Ibid.
[55] (2006). Grade Retention: What's the Prevailing Policy and What Needs to be Done? Los Angeles, CA, UCLA**:** 15.

Evidence suggests that basic school restructuring can help a high school avoid the social promotion/retention conundrum.[56] The challenge is to create a "continuum of interconnected intervention systems" that effectively address barriers to learning and allow problems to be solved proactively.[57] Non-graded and multi-age classes, looping, and "promotion gates" are structural components that demonstrate the potential to add the necessary flexibility. But there are significant constraints, systemic and political, that make implementing this type of innovation difficult.

In theory, students should be able to move through the curriculum at an appropriate pace without "failing" **or** being exempted from accountability for their performance. But in addition to external and design challenges, staff members must be willing to experiment with a system that has not been proven.

3. Providing extra support during important transition years

Counseling systems that intend to support students as they transition from high school to college are overwhelmed and ineffective. Many Pittsburgh Public high schools have student to counselor ratios that make meaningful relationships between students and counselors infeasible and ineffective. For example, Langley and CAPA High Schools have only 1 counselor that serves upwards of 550 students, while Carrick, Oliver, Brashear, and Allderdice High Schools have 1 counselor that serves upwards of 375 students.[58] Ambitious students may access help, and exceptional counselors may be able to make some contact with all of the students in the grade but the overwhelming student to counselor ratio dooms the system as a whole. Generally schools simply graduate as many students as they can and hope for the best.

There is a comparable lack of support in other important transition years. In Pittsburgh Public Schools, nearly one-fourth of ninth-graders do not earn the necessary credits to be promoted to the tenth grade. Experts judge ninth grade to be the critical year for projecting whether a student will graduate from high school.[59] Additionally, many reform models and academic researchers recommend giving special structural treatment to the ninth grade.[60]

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[56] Davenport, S., Antonio Delgado, Marlene Meisels, Donald R. Moore (1998). Rethinking Retention to Help All Students Succeed: A Resource Guide. Chicago, Illinois, Designs for Change**:** 14.
[57] (2006). Grade Retention: What's the Prevailing Policy and What Needs to be Done? Los Angeles, CA, UCLA**:** 15.
[58] PPS. (2007)"Pittsburgh Public Schools Student Services Staff." Retrieved October 8, 2007, from ???? (Be sure to add to bibliography)
[59] Chute, E. (1999). Back to School: Ninth grade proves to be a pivotal year for youths. Pittsburgh Post-Gazette. Pittsburgh, PA.
[60] Daggett, W. R. (2004). America's Most Successful High Schools: Case Studies and Resources on Best Practices. Rexford, NY, International Center for Leadership in Education**:** 392.
Legters, N. E., J. M. McPartland, et al. (2004). Scaling Up Talent Development High Schools: Lessons Learned From Comprehensive High School Reform. Expanding the reach of education reforms : perspectives from leaders in the scale-up of educational interventions. T. K. Glennan and Rand Education (Institute). Santa Monica, CA, RAND**:** 379-431.
Quint, J. (2006). Meeting Five Critical Challenges of High School Reform: Lessons From Research on Three Reform Models. New York, NY, MDRC**:** 89.

Students also receive little emotional or academic support when they transition from elementary to middle school, typically after the fifth grade. The expansion of K-8 schools in Pittsburgh is a positive development in this area, but many students still move into a new building or a new type of academic schedule after the fifth grade. They usually find less rather than more support as they navigate this difficult developmental transition.

4. Overcoming poor completion and graduation rates

Only 64 percent of Pittsburgh Public School students graduate from high school within five years. Thirty five percent drop out without graduating, and less than two percent remain in high school after five years. For male students, the graduation rate is only 59 percent and for black students, it is only 58 percent. 70 percent of non-black students graduate from Pittsburgh Public Schools. These numbers, while distressingly low, place Pittsburgh in the middle of the range of average graduation rates for large urban districts nationwide. Interestingly, approximately 10 percent of PPS students complete high school in a 5th year.[61]

5. Ensuring access to and success in advanced coursework

In addition to completion, the organizational structure must support significant gains in student achievement in the form of advanced coursework. Advanced coursework can be defined at the school, the district, or the national level, but it should be the expected outcome for all students, not just for exceptional children who enter school at an advanced academic level.

Traditionally, advanced coursework is defined in comparison to "non-advanced" coursework, or coursework completed by "non-advanced" students. However, this is no longer an appropriate definition. Instead, advanced coursework must be redefined as coursework that is aligned with the expectations of universities and potential employers. Regardless of the academic deficits that a student brings to the school, they should receive the support and time necessary to meet these expectations.

It is never easy to redefine a commonly accepted paradigm. For decades advanced coursework has been reserved for advanced students. The redefinition of advanced coursework does not mean that all students in the system should complete AP Calculus. It does mean, however, that regardless of the student's area of interest or academic concentration (whether bricklaying or computer science), all students should be expected to exceed the level of work expected for entry into a university or employer in their field before their graduation.

Advanced Placement (AP) tests are one only one form of advanced coursework, but they provide an appropriate benchmark, demonstrating the need for a significant change in

[61] Engberg, J. and B. Gill (2006). Estimating Graduation and Dropout Rates with Longitudinal Data: A Case Study in the Pittsburgh Public Schools. Pittsburgh, PA, RAND Corporation

district wide expectations. Only 301 AP exams were passed in all Pittsburgh Public Schools in 2004- 05. The data indicates a particular need to focus on ensuring that African American students access and succeed in advanced coursework. African American students passed only 5 of these 301 tests.[62]

Conclusion

In summary, a new public school must be designed to overcome a significant set of challenges. Ultimately it must be equipped to take a diverse group of incoming students, many of whom will be entering below grade level, move them through a "continuum of interconnected support systems," and connect them to advanced coursework and a postsecondary opportunity. Succeeding in this process requires overcoming the nine challenges described here.

A clearly defined educational theory is the first step towards overcoming these challenges. This theory should be research driven and carefully defined. It should be designed in direct response to these barriers to success and it should guide all educational and structural decisions. The accompanying section, titled *Addressing the Challenge*, describes this educational theory, and the fundamental decisions that will allow Pittsburgh Science and Technology to realize the core principles of the High School Reform Task Force.

Sam Franklin, 2008

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[62] Roosevelt, M. (2006). Excellence For All: A Four-Year Comprehensive Framework for Improvement.

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Step 3: Developing a Program Theory through Collaboration and Research

Introduction

One and a half years of intensive research have made it very clear that there is not one recipe for overcoming the nine challenges identified in *Defining the Challenge*.[63] Instead, schools that are achieving outstanding results look very different from one another. "Breakthrough" schools have different sizes, different schedules, and different systems. They do not share a curriculum or have a similar technology plan.

However, despite their differences, successful schools do share some common characteristics. Successful schools have a well defined outcome goal for their students. They also are guided by a set of fundamental decisions. Although these decisions are not always clearly defined or communicated, they form a coherent program theory, a strategy for overcoming the challenges identified and achieving the goal that has been established.

Ideally, these decisions are a constant presence in the school. They should be drawn from a diverse set of research relevant to public education, and should be referenced when difficult decisions are being made. It is these philosophical and strategic decisions that inform all educational elements of the school and unite the various systems that operate within it.

In this essay fundamental decisions are presented in three categories, (1) Philosophical decisions; (2) Strategic decisions; and (3) Systemic decisions. A comprehensive body of research contributed to these decisions, and guides learning at Pittsburgh Science and Technology. An introduction to this research precedes an explanation of the decisions themselves. Please see the final essay in this series, *Sample Sources*, for an identification and explanation of important sources in each research category. A complete bibliography is included with the report.

Research Methods

The significant body of research that has contributed to the design of Pittsburgh Science and Technology is organized into three primary categories; (1) Secondary literature review, (2) Benchmarking and best practice research, and (3) Primary research. At the end of this document, important sample sources from each of these categories are summarized.

1. Secondary Literature Review

[63] *Defining the Challenge* is the previous essay in this report.

A broad secondary literature review continues to contribute to the PST design and implementation process. The review began with several books designed to provide background on the challenges related to urban public education in the 21st century. It expanded to include journal articles obtained primarily through ERIC, the Education Resources Information Center, and JSTOR, an online archive of academic journals. Dozens of reports, evaluations, and newspaper and internet items were subsequently reviewed. The content of these secondary sources fits into five primary subcategories:

a. **Education theory –** Including Alfred North Whitehead's essays *Aims of Education* and *Rhythms of Education*;
b. **Education Policy Research** – Including more than 150 books, reports, journal articles, and evaluations related to Organizational Structure, Curriculum, Budgeting, Professional Development, Technology Integration, Human Resources, Partnership Development, and more;
c. **Historic and historiographical analysis -** Consisting of approximately 50 books and essays;
d. **Science and technology specific history, theory, and cognitive development sources;** and
e. **Case studies**.

2. Benchmarking and Best Practice Research

In addition to information obtained in the secondary source review, dozens of existing schools and comprehensive school reform models were studied. The research and design team worked to identify best practices for each of the systems that operate within a school. Benchmarking focused on Organizational Structure, Curriculum, Staff and Administrative Composition, Professional Development, Curriculum, Technology Integration, Location, Facilities, and Transportation, Budget, and Public and Private Partnerships.

We first consulted a list of the Top 1,000 US Public Schools identified by Newsweek. We focused upon the top 100 schools on the list, and then further narrowed the list by focusing solely upon schools in which at least 35 percent of the students received free or subsidized lunches. This constraint was placed to give attention to schools with students of similar socioeconomic circumstances to PPS students, and to eliminate schools with greater financial resources.

We also benchmarked a number of schools that are members of the National Consortium for Specialized Secondary Schools of Mathematics, Science, and Technology (NCSSSMST). This consortium consists of schools whose primary purpose is to academically prepare students for leadership in mathematics, science, technology fields. Benchmark Schools include:

a. Thomas Jefferson High School for Science and Technology, Alexandria, VA;
b. South Carolina's Governor's School for Science and Mathematics; and

c. Academy for the Advancement of Science and Technology, Hackensack, NJ.

In addition to schools identified through these two sources, we benchmarked Comprehensive School Reform Models, Breakthrough High Schools identified by the National Association of Secondary School Principals (NASSP), and outstanding or unique schools identified through word of mouth or through our secondary literature review. Benchmark schools include:

a. Talent Development High Schools, Center for Social Organization of Schools, Johns Hopkins University;
b. School Without Walls, Rochester, NY;
c. The Denver School of Science and Technology, Denver, CO;
d. University Park Campus School, Worcester, MA;
e. Creative and Performing Arts High School, Pittsburgh, PA; and
f. Urban Academy, New York, NY;

Please see the following essay titled *Sample Sources* for a description of how these influential schools informed our design.

3. Primary Research

Finally, three types of primary research contributed to the original design and continue to improve and expand it during the implementation phase. The three types of primary research are described below.

a. **School visits –** Team members have now visited a diverse sample of schools in Southwestern Pennsylvania and in other cities including New York, Oakland, Denver, Boston, and Milwaukee. Visited schools include private, public, and charters at the elementary, middle, and high school levels.
b. **Focus groups –** Focus groups composed of experts in science and technology education have been convened to address specific questions primarily related to curriculum development. These focus groups did not contribute significantly to the original design, but have influenced its expansion and revision, and are an important part of the implementation plan.
c. **Consultation, Interviews and Personal Communication** – The input of parents, professors, teachers, administrators, nonprofit sector and industry representatives, and regional leaders have been an important part of the design. These communications range from formal interviews and Advisory Board meetings to informal discussions and emails.

Together, these sources led to the following set of fundamental decisions. These decisions guide decision making during implementation and provide the foundation for the systems that will operate at Pittsburgh Science and Technology.

Philosophical Decisions

Together this significant set of sources has led to the following decisions, decisions which should guide curriculum development and scheduling.

1. Build the program, lessons, and sequences to align with the "Rhythms of Education".

In his famous essay titled *Rythms of Education* Alfred North Whitehead describes three essential stages of education. He argues that all learning should progress through each of the following stages.[64]

A. **The stage of romance**, when the subject matter has "the vividness of novelty" and the excitement of unexplored connections.
B. **The stage of precision**, when "width of relationship is subordinated to exactness of formulation". This stage is deemed the "stage of grammar", the grammar of language and the grammar of science. According to Whitehead, precision is nothing without being preceded by romance because there must be a broader context for the facts and a general understanding of their context.
C. **The stage of generalization** or synthesis. This stage is "a return to romanticism" with "the added advantage of classified ideas and relevant technique".

The graphic below outlines how the PST curriculum seeks to align with an adapted version of Whitehead's Rhythms of Education.[65] The full PST curriculum, units, and daily lessons will be designed and implemented according to these three stages.

"Rhythms of Education"	Modified Key Words	Lessons	Units	Full PST Program
Romance "the vividness of novelty" and the excitement of unexplored connections	**Dream**	Open lessons with a "hook" that inspires curiosity, establish objectives and assess results	Generate questions, set big goals, generate ideas	Students demonstrate curiosity, creativity, and entrepreneurship while consistently monitoring progress toward long term goals
Precision "width of relationship is subordinated to exactness of formulation"	**Discover**	Conduct research and discover new skills and/or information	Acquire knowledge and skills through research	Students constantly lead and participate in research and exploration
Generalization "a return to romanticism" with "the added advantage of classified ideas and relevant technique"	**Design**	Apply new information/skills to real situations or new types of problems, produce something tangible	Apply knowledge and skills to answer questions through inquiry driven projects which produce something tangible	Research and exploration consistently culminates in an object or product which can be touched, presented or displayed

[64] Whitehead, A. N. (1929). The Rythms of Education. The Aims of Education and other essays. New York, NY, The Free Press, A Division of Macmillan Publishing Co., Inc.: 13.
[65] Alfred North Whitehead's Rhythms of Education are explained in the previous section of this document.

2. Recognize the cognitive potential of all students and accept responsibility for their achievement.

PST believes in the ability of all students to succeed in advanced coursework and connect to a relevant postsecondary opportunity. Outstanding schools are currently supporting this conclusion by connecting more than 90% of students to college, including students who entered with significant academic deficits.

The fact that all students have the *potential* to succeed in advanced coursework and access a personally meaningful postsecondary opportunity does not mean that a traditional school is equipped to realize this possibility. A school that is willing to accept responsibility for the success of all students and design academic programs and support systems to meet this challenge will achieve this.

Furthermore, all students are not capable of meeting the demands of advanced coursework in the same amount of time, or with the same level of support. Some students will require significantly more academic time and academic support to develop the prerequisite skills, study habits, and confidence necessary to tackle advanced work. Therefore the school must build flexible systems for promotion, and a continuum of interconnected support systems capable of meeting changing needs of individual students in real time.

It is not expected that all students will graduate at the same level. Certainly some students, through a combination of innate ability and external circumstances, have the ability to move well beyond the high expectations established for all attendees. However, it is the expectation that all students will graduate having reached a threshold that includes advanced coursework and ensures that they are prepared to meet the expectations of higher education or the 21st century workforce.

Finally, in an ideal situation, families would have the resources and ability to support their high school senior secure an opportunity in postsecondary education or find a job. However, this is not the reality. Therefore, rather than blaming families as they watch students grasp for opportunity, schools in the twenty first century must be willing to accept responsibility for connecting students to an appropriate opportunity. Postsecondary preparation must be built into the school day.

The school must recognize that all students have the potential to succeed academically while at the same time understanding that students have different needs and abilities at different times. Instead of a specific age based framework for learning, "what children are capable of at a particular age is the result of a complex interplay among maturation, experience, and instruction. What is developmentally appropriate is not a simple function of age and grade, but rather is largely contingent upon opportunities to learn".[66]

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[66] Duschl, R. A., H. A. Schweingruber, et al., Eds. (2007). Taking Science to School: Learning and Teaching Science in Grades K-8. Washington, D.C., The National Academies Press.

3. Understand that excellent teaching is the key to success.

Standardized testing and data collection allow researchers to accurately isolate the impact of a single district, school, or teacher on student achievement. A 2005 RAND study conducted in Pittsburgh combined three methods of analyzing school effects to create a School Performance Index, a methodologically valid measure of the educational impact of a school on its students, independent of family or neighborhood factors.[67] Similar studies in Tennessee, Texas, Massachusetts, and Alabama have isolated the impact, or "value-added," of a single teacher.

The results of these "value-added" studies demonstrate the tremendous impact that a single teacher has on the academic trajectory of his or her students. For example, in Tennessee, the difference in academic gains produced by the most effective and least effective teachers averages between 35 and 40 percentile points in a single school year, an effect that is multiplied by a string of either effective or ineffective teachers.[68] Together, these studies led The Education Trust to conclude that teachers are the single biggest factor in determining the achievement of a student, greater even than poverty, race, or parents' education level.[69] The Alliance for Excellent Education adds that "persuasive research demonstrating the relative importance of instruction for student achievement – as against other contextual factors – has brought about a dramatic emphasis in recent years on the quality of teaching."[70]

Because it is clear that the quality of instruction will determine the success of Pittsburgh Science and Technology all systems must be designed to attract, develop, and retain excellent teachers. The time constraints, isolation, poor scheduling, burdensome development requirements, and ineffective evaluation systems that contribute to the frustration often felt by teachers in urban public schools must be resolved.

Thus PST hopes to pilot a new "professional approach to teaching". This is characterized by a respect for and empowerment of teaching professionals. Teachers have more time to develop quality lessons, have structured time for collaboration, see less students each day, benefit from professional development that is self-guided and during the school day, and participate in systemic decision making.

Treated like professionals, these teachers are also expected to produce professional results. Given the unique systems that make success possible and development productive, teachers should produce significant academic gains. A new system of accountability will measure results accurately and evaluate teachers accordingly.

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[67] Gill, B., Engberg, J. & Booker, K (2005). Assessing the Performance of Public Schools in Pittsburgh. RAND Corporation Working Paper. Pittsburgh, PA, RAND**:** 1-24.

[68] Carey, K. (2004). "The Real Value of Teachers: If good teachers matter, why don't we act like it?" Thinking K-16 8(1): 44.

[69] Haycock, K. (1998). Good Teaching Matters: How Well Qualified Teachers Can Close the Gap. Washington, DC, The Education Trust**:** 16.

[70] (2004). Tapping the Potential: Retaining and Developing High-Quality New Teachers. Washington, DC, Alliance for Excellent Education**:** 80.

4. Seek to operate in Pasteur's Quadrant.

The relationship between the quest for fundamental understanding on one hand, and considerations of use on the other has been a subject of continuous debate in the scientific community. Similarly, there is historic disagreement about the relationship between science and technology. For the past sixty years, the former view - of science as a quest for fundamental understanding independent of utility or application - has been predominant. Technology has been viewed as a product of pure science rather than vice versa.

Donald Stokes influential book Pasteur's Quadrant challenges these popular perceptions.[71] He demonstrates that science has historically been a product of technology more than technology a product of science. He suggests that, ideally, scientific exploration should be inspired both by considerations of use *and* by a quest for fundamental understanding. Louis Pasteur is identified as an example of a scientist whose work combined these two purposes which were often viewed as incompatible. Thus, science and technology are not separated, with one being the product of the other, but they are brought together in "Pasteur's Quadrant".

At Pittsburgh Science and Technology, science and technology are brought together in four SciTech concentrations. Inquiry driven projects seek to integrate the practical with the purely scientific. Certain experiences ask students to solve problems by developing technology, solving the problem, and then formulating a scientific explanation, a technology first approach. Other projects ask them to formulate a scientific explanation, and then test it with technology, or to create a technology tool as the product of a scientific exploration.

While students will learn technology skills such as Microsoft Office, Internet, keyboarding skills, and other technology basics, this is not the "technology" in Pittsburgh Science and Technology. We believe that students should acquire these important skills in *all* Pittsburgh Public Schools. Instead, technology in PST is understood on several levels:

A. A set of basic skills that all students should master;
B. Tools that improve instruction and communication;
C. A set of high level skills that empower complex problem solving;
D. A driving force in scientific advancement and exploration today and throughout human history;
E. An element of the "utility" that should exist in scientific processes; and
F. A product of scientific research.

[71] Stokes, D. E. (1997). Pasteur's quadrant : basic science and technological innovation. Washington, D.C., Brookings Institution Press.

5. Balance depth and breadth but emphasize breadth.

In *Aims of Education* Alfred North Whitehead cautions against "teaching small parts of a large number of subjects". Instead he advocates teaching fewer subjects very thoroughly, and doing so in a way that explores their connections with other disciplines. He suggests that, "What education has to impart is an intimate sense for the power of ideas, for the beauty of ideas, and for the structure of ideas, together with a particular body of knowledge which has peculiar reference to the life of the being possessing it".[72]

Our research and benchmarking support Whitehead's thesis. We found that students are more likely to stay in school, retain information, and score higher on standardized tests when their education includes opportunities for in depth exploration. Maximum results were achieved when these in depth experiences were tailored to the specific interests of the student or group of students, empowering them to become experts in a field that is personally significant.

We do not expect that all graduates of Pittsburgh Science and Technology will become scientists. But by focusing instruction with specific Science and Technology themes and allowing students to acquire information through the pursuit of a field of interest, students will acquire thinking and learning skills that can be applied to any other experience.

Choosing depth over breadth requires willingness by the school and the teacher to integrate standards that are often taught disparately. More controversially, it requires willingness to bypass certain standards altogether in order to teach others in great depth. The staff must analyze state standards, identifying those that are most important. Students and outside experts should be included in this process.

Linda Darling Hammond argues that "schools can demand rigorous intellectual work from students only if they are willing to forgo the goal of superficial content coverage." Successful schools follow the Coalition of Essential Schools' (1994) guiding principle of "less is more," carefully choosing what to focus on so that students gain in-depth understanding, rather than superficial exposure to large quantities of information. This applies not just to curricular choices "but also to the entire school program".[73]

Selecting the 125 most "fundamental" standards from a list of 200 does not mean selecting the easiest, or the most basic. To the contrary, it means selecting the concepts that are the most fundamental to mastering the discipline, to solving problems, and to the continuing pursuit of the discipline. In fact, the easier concepts should not always precede the harder concepts, and difficulty should not be something that is avoided or postponed.

Common sense recognizes that it is difficult to make instructional sacrifices. The current paradigm understandably emphasizes offering as many courses as possible and touching

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[72] Whitehead, A. N. (1929). The Aims of Education. <u>The Aims of Education and other essays</u>. New York, NY, The Free Press, A Division of Macmillan Publishing Co., Inc.**:** 14.
[73] Darling-Hammond, L. (2002). Redesigning Schools: 10 Features of Effective Design. Stanford, CA, School Redesign Network, Stanford University**:** 75.

on as broad a range of standards and skills as can be taught in a single school year. This thinking is based on a legitimate desire to expose students to the exciting breadth of knowledge that exists in every discipline.

But the desire to expose students to every piece of information must be resisted by understanding the importance of in depth exploration. It is exploration and inquiry, and the deep interaction with fundamental ideas that engages students in their education and teaches the higher order thinking skills necessary for success in a dynamic economic era.

Strategic Decisions

1. Add flexibility to the traditional age-graded system.

In our "age-graded" school system there are two alternatives for addressing the needs of students who do not meet expected achievement standards. Unfortunately, neither retention nor social promotion addresses the needs of the student. Neither one impacts student achievement, contributes to closing the achievement gap, or reduces dropout rates.[74] A new urban school should break out of the traditional age graded system that leaves administrators and teachers with these two unfortunate choices. Basic school restructuring can help a high school avoid the social promotion/retention conundrum.[75]

In abandoning the age-graded system, the challenge is to create a “continuum of interconnected intervention systems” that effectively address barriers to learning and allow problems to be solved proactively.[76] Non-graded and multi-age classes, looping, and “promotion gates” are structural components that are currently being used by innovative schools to create this type of flexible program.

2. Emphasize interdisciplinary education and experiences.

In accordance with our decision to emphasize in-depth exploration and provide coursework that integrates the practical with the purely academic, we feel that it is important to emphasize interdisciplinary experiences.

Currently, high school students in the United States score below their international peers in math and science. In Pittsburgh, 35.6 % of 11th graders perform at a below basic level in math.[77] Therefore, it is more vital than ever that teachers make coursework in math and science relevant, accessible, and exciting to students. Teaching practices and topics

[74] (2006). Grade Retention: What's the Prevailing Policy and What Needs to be Done? Los Angeles, CA, UCLA**:** 15.
[75] Davenport, S., Antonio Delgado, Marlene Meisels, Donald R. Moore (1998). Rethinking Retention to Help All Students Succeed: A Resource Guide. Chicago, Illinois, Designs for Change**:** 14.
[76] (2006). Grade Retention: What's the Prevailing Policy and What Needs to be Done? Los Angeles, CA, UCLA**:** 15.
[77] (2007). District's 2007 PSSA Test Scores Show Gains for Second Consecutive Year. Pittsburgh Public Schools News. Pittsburgh, Pittsburgh Public Schools Communications and Marketing.

that arouse student interest "can help motivate students to learn and increase achievement."[78]

In our system, teachers work in an interdisciplinary framework to determine a topic or theme, incorporate appropriate student skill development, and integrate it into the curriculum. Coursework will use specific concentrations, projects, and themes to combine and teach broader and traditional subject areas.

3. Provide additional support during transition years.

We recognize a need to focus additional resources and energy to support students through important transition years. The transition from 5th to 6th grade, 8th to 9th grade, and 12th grade to postsecondary education or employment can be the most challenging for students, particularly for those who do not have a strong family support system.

Data collected about the ninth grade provides an example of the need for additional academic support and structure during these transitions. Ninth grade is often considered to be the most challenging grade for students. In addition to academic pressures, students face social pressures and often have trouble transitioning from middle school to high school. School districts nationwide, including PPS, report that roughly 20 percent of all 9th graders are being retained. Additionally, the largest percentages of failing grades are exhibited at the 9th grade level, 25.5 percent, compared to 5.7 percent in the 8th grade. In order to address some of these problems, some high school curricula are specially tailored to assist 9th graders in the transition from middle school to high school through the creation of interdisciplinary 9th grade academies.[79]

4. Create additional instructional time and emphasize "time on task".

Additional instruction time for students who are struggling in math is recommended by organizations such as the Bill and Melinda Gates Foundation.[80] Increasingly, high schools are exploring the option of extending Algebra I from a one-year course to a two-year course. In addition, comprehensive high school reform models, such as Talent Development High Schools (TDHS), recommend reserving an additional class period for "transitional" or "challenge" classes. The emphasis on "time-on-task" also applies to teachers, who should have professional development opportunities built into the school day, and have time in their schedule to plan, analyze student work, and handle their classroom's administrative responsibilities.

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[78] Bloom, R. D. S. and M. J. Halpin (2002). "Integrating Pharmocology Topics in High School Biology and Chemistry Classes Improves Performance." Journal of Research in Science and Teaching **40**(9): 922-938.
[79] Chute, E. (1999). Back to School: Ninth grade proves to be a pivotal year for youths. Pittsburgh Post-Gazette. Pittsburgh, PA..
[80] (2006). Improving Math Performance. Seattle, WA, Bill & Melinda Gates Foundation**:** 6.

Systemic Decisions

1. Implement a block schedule.

Although there are challenges associated with block scheduling it has the potential to increase student engagement, improve student attitudes, and decrease both absenteeism and disciplinary infractions. The block schedule also allows teachers more time for differentiated instruction and for teaching problem-solving skills.[81]

2. Develop inquiry-driven, project-based coursework and emphasize "authentic instruction".

A comprehensive meta-analysis of existing evaluations of math and science curricula and professional development system identified and analyzed math and science curricula that have been evaluated and use student achievement as criteria for judging results. This study found that inquiry based science curricula demonstrate the greatest impact on student achievement.[82]

A 1995 study by Newmann, Marks, and Gamoran supports the ability of authentic curricula to affect student outcomes. Their study of more than 2,000 students in 23 restructured schools, most of them in urban areas, found much higher levels of achievement on complex performance tasks for students who experienced what these researchers termed "authentic pedagogy"— instruction focused on active learning in real-world contexts calling for higher-order thinking, consideration of alternatives, extended writing, and an audience for student work.[83]

Interdisciplinary, project based courses are consistently preferred by students. Instead of tedious math or science worksheets or drills, students prefer to participate in projects that they can relate to real-world applications.

3. Design curricula that are aligned with educational and economic opportunities.

Education reform should not take place in a vacuum. Challenges facing the education system are inherently linked to social, community, and economic issues, and reform should be conducted with this understanding. Aligning reform with larger social and economic changes is a significant challenge, but at the very least students should acquire skills which will empower them to succeed in the economy of the day. Without a strong connection between high school standards and the expectations of both postsecondary institutions and employers, "the high school diploma will remain a credential of little

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[81] Lewis, R. W. (1999). Block Scheduling: Changing the System, University of West Alabama**:** 11.

[83] Darling-Hammond, L. (2002). Redesigning Schools: 10 Features of Effective Design. Stanford, CA, School Redesign Network, Stanford University**:** 75.

value."[84] Accordingly, high schools that focus specifically on the subject areas of mathematics, science, and technology are growing in number, as jobs in these areas continue to increase.

In undertaking such reforms, high school curricula are adapting to the needs of students by moving away from the traditional high school model and developing programs that provide students with both the professional *and* intellectual backgrounds that they will need for success in the 21st century global economy. High schools must collaborate with colleges and business to more closely align standards to college and work place expectations.[85]

Program Theory

Best practice in program evaluation demonstrates the utility in starting with a clearly defined outcome goal, program theory, and logic model. An organization that has articulated the specific outcomes that it intends to achieve (the outcome goal), and the path that it believes will lead to this outcome (the program theory) is much easier to understand and evaluate than an organization without these programmatic assets. Both outcome-based and performance-based evaluation can be readily designed when these prerequisites are in place.

Outcome-based evaluation compares results being achieved to the anticipated results as identified by the outcome goal. Performance based evaluation tests how closely the organization's *actual* implementation of its programs matches the *desired* implementation processes and characteristics as explained by the program theory, and graphically illustrated by the logic model. Thus it can be determined if the desired results are being obtained, and, if they are not being achieved, if that is so because the programs are not being implemented as intended or because the theory itself is flawed.

Program evaluation is particularly important for an innovative institution such as the Pittsburgh Science and Technology Thematic Learning Community. This is so because testing innovations can inform the improvement of the school itself but also support the expansion of successful systems across the district, increasing access to systems that work.

The Systems Synthesis team that created the original school design integrated these important components of organizational strength into their design. Phase 5, Performance Management and Evaluation, focuses on data collection and program improvement through evaluation at all levels of the school. Rigorous evaluation at the District, administrative, and classroom level should compare implementation to theory and actual outcomes to the student outcome goal. **The specific strategy for this ongoing evaluation process should be considered throughout the implementation process. Important elements of this strategy include determining:**

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[84] (2006). Closing the Expectations Gap 2006: An Annual 50-State Progress Report on the Alignment of High School Policies with the Demands of College and Work. Washington, D.C., Achieve, Inc. **:** 32.
[85] Ibid.

- **Who will collect the data;**
- **What data will be collected;**
- **How the data will be collected;**
- **Who will analyze it; and**
- **How the results of this analysis will be used to change and improve systems and outcomes should be considered throughout the process.**

The following sections, describing the program theory and including a logic model, are designed to facilitate evaluation in 2013 when Phase 5 officially begins. But they are also a starting point and important reference for more immediate implementation decisions.

Using the Student Outcome Goal to Implement Impact Evaluation

The preliminary design of PSTHS establishes the foundation for successful evaluation. The clearly defined student outcome goal is the starting point. The following table identifies three specific and measurable outcomes established by this goal. It defines them and suggests tools for evaluation.

Goal	**Description**	**Evaluation**
Graduating all students	The goal of PSTHS is to graduate 100 percent of its students. That is, all students that enter the school at the Associate Level will graduate within five years unless they move or transfer from the Thematic Learning Community to another Pittsburgh school.	Progress towards this goal will be measured by tracking the graduation rate.
Preparing all students for postsecondary success	All students will be academically and developmentally prepared for postsecondary success, either in a job or in higher education, before they graduate and within five years of entering PSTHS.	Progress towards this goal should be measured in several ways. Initial progress can be measured through the analysis of PSSA scores, AP tests, SAT scores, and success in advanced inquiry-based courses. However, mechanisms for determining preparedness for postsecondary success cannot be measured exclusively by examining student achievement. A system that uses statistical tools and measures that monitor the long-term success of PSTHS alumni must also be developed and used. It could be accomplished in an annual report based on a randomized sample, or an alumni database that tracks graduates.
Connecting all students to a postsecondary opportunity	All students will leave the school connected to a college or work opportunity. They will have a job, an internship, or will have accepted an	The Dean of Students is responsible for monitoring the progress of students through levels and concentrations. PSTHS administrators should also work with the

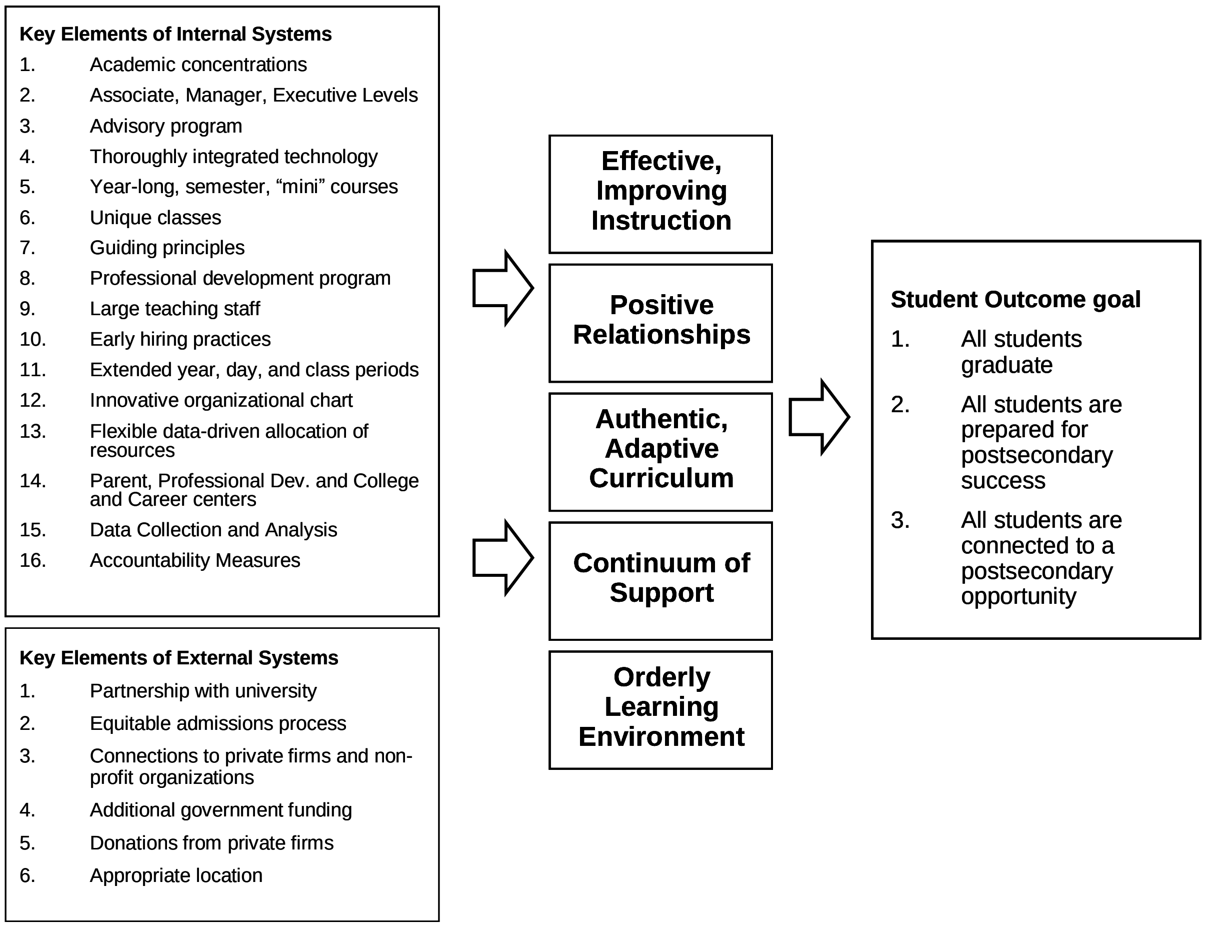
	offer of admission to a community college, college, or university. Travel opportunities or exchange programs are also considered to be postsecondary opportunities.	College and Career Officer to develop a system for measuring college admission rates and connections to jobs.

Using Program Theory to Facilitate Process Based Evaluation

The relationship between the activities that make up the program and the outcomes that the program is anticipated to produce is explained by the program theory. Well-designed program theories explain *why* and *how* these activities will lead to the stated outcome and support this causal relationship with evidence. Program theory is an important evaluation tool. Evaluators use program theory to compare the program as it is actually happening at the school with the program as it is described in the theory. This type of evaluation makes important conclusions possible. For example, finding that the program is not being implemented as described in the theory might explain why the desired outcomes are not being achieved. Ultimately, program evaluations such as these will help administrators and teachers identify areas in the program process that require change.

A logic model is a picture, or graphic representation of the program theory. The logic model in Figure 1 below provides a starting point for creating a fully developed program theory.

Figure 2. Program Evaluation Logic Model



Value-Added Measurement and the School Performance Index (SPI)

Both the state of Pennsylvania and the city of Pittsburgh have recently begun to utilize value-added measures to assess the impact of a school on student achievement. In Pittsburgh, the RAND Corporation developed the School Performance Index (SPI). The School Performance Index "uses statistical regression techniques and longitudinal analyses of the achievement of individual students over time to estimate each school's contribution to the achievement growth of its students." Similarly, the Pennsylvania State Board of Education is gradually implementing the Pennsylvania Value-Added Assessment System (PVAAS) in districts across the Commonwealth. These value added measures are a fair assessment of the impact of a school because they effectively isolate family and neighborhood factors. The Pittsburgh Science and Technology High School should utilize both of these value-added measures, setting specific numerical goals for growth according to each indicator.

It is not necessary that the value-added measurement system is in place when the school opens in August of 2008. However, the data collection tools should be in place well before the beginning of Phase 5 so that value-added data can become a fundamental component of continuing performance management and evaluation. Furthermore, it is recommended that PST serve as a pilot campus for the type of value-added teaching measures that can be used to made decisions about merit-based bonuses and teacher retention.

An evaluation plan, particularly for process based evaluation, and a partner who is willing to conduct this research at little or no cost is needed before the school opens in 2008.

Sam Franklin, 2008

(2004). Tapping the Potential: Retaining and Developing High-Quality New Teachers. Washington, DC, Alliance for Excellent Education**:** 80.

(2006). Closing the Expectations Gap 2006: An Annual 50-State Progress Report on the Alignment of High School Policies with the Demands of College and Work. Washington, D.C., Achieve, Inc. **:** 32.

(2006). Grade Retention: What's the Prevailing Policy and What Needs to be Done? Los Angeles, CA, UCLA**:** 15.

(2006). Improving Math Performance. Seattle, WA, Bill & Melinda Gates Foundation**:** 6.

(2007). District's 2007 PSSA Test Scores Show Gains for Second Consecutive Year. Pittsburgh Public Schools News. Pittsburgh, Pittsburgh Public Schools Communications and Marketing.

Bloom, R. D. S. and M. J. Halpin (2002). "Integrating Pharmocology Topics in High School Biology and Chemistry Classes Improves Performance." Journal of Research in Science and Teaching **40**(9): 922-938.

Carey, K. (2004). "The Real Value of Teachers: If good teachers matter, why don't we act like it?" Thinking K-16 **8**(1): 44.

Chute, E. (1999). Back to School: Ninth grade proves to be a pivotal year for youths. Pittsburgh Post-Gazette. Pittsburgh, PA.

Darling-Hammond, L. (2002). Redesigning Schools: 10 Features of Effective Design. Stanford, CA, School Redesign Network, Stanford University**:** 75.

Davenport, S., Antonio Delgado, Marlene Meisels, Donald R. Moore (1998). Rethinking Retention to Help All Students Succeed: A Resource Guide. Chicago, Illinois, Designs for Change**:** 14.

Duschl, R. A., H. A. Schweingruber, et al., Eds. (2007). Taking Science to School: Learning and Teaching Science in Grades K-8. Washington, D.C., The National Academies Press.

Gill, B., Engberg, J. & Booker, K (2005). Assessing the Performance of Public Schools in Pittsburgh. RAND Corporation Working Paper. Pittsburgh, PA, RAND**:** 1-24.

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Stokes, D. E. (1997). Pasteur's quadrant : basic science and technological innovation. Washington, D.C., Brookings Institution Press.

Whitehead, A. N. (1929). The Aims of Education. The Aims of Education and other essays. New York, NY, The Free Press, A Division of Macmillan Publishing Co., Inc.**:** 14.

Whitehead, A. N. (1929). The Rythms of Education. The Aims of Education and other essays. New York, NY, The Free Press, A Division of Macmillan Publishing Co., Inc.**:** 13.

Step 4: Implementation and Revision

Utilizing the research and design expertise of Pittsburgh's strong universities, Mr. Roosevelt engaged a team of graduate level researchers from the H. John Heinz III School of Public Policy and Management to complete the initial design and planning phase of this school through best practice research, engagement with community experts, a secondary literature review, and data analysis. The ten members of the project team concluded their study in December of 2006 and presented their recommendations to the Board in January of 2007.

Between January and May of 2007 four graduate students from the original project team continued their work. The curriculum framework was expanded and revised as systems were integrated into a working master schedule. Simulations of student flow through PST based on PSSA and PPS data allowed the team to provide initial estimates of the number of courses, teachers, and students that would allow the school to operate as designed.

In July 2007 Pittsburgh Public Schools staff assumed full responsibility for the revision and implementation of the project. The School Board, with the support of the Buhl Foundation, hired project manager Sam Franklin and consultants Judy Hallinen (CMU) and Michele Cheyne (University of Pittsburgh) to lead revision and implementation. This work is ongoing, advised by a Steering Committee and managed through the Office of High School Excellence.

The Board charged this team with developing an actionable plan and implementing it. It was recommended that this plan include analysis and identification of graduation requirements, the development of science concentrations, courses being offered in different amounts of time, and flexible mechanisms for promotion that might allow students to accelerate their program.

More than 200 community experts representing the for-profit, not-for-profit, K-12 education, and university sectors have contributed directly to this design. Secondary research drew from more than 175 books, reports, and journal articles. Team members researched, visited and spoke to representatives from dozens of successful public schools, many of which focus their curriculum in science, technology, engineering, or math

The school is scheduled to open in 2009 with 250 students in the 6^{th}-9^{th} grades. It proposes five primary innovations designed to provide the flexibility and support necessary to challenge every student in a safe and exciting learning environment. This report introduces these innovations, provides an overview of the proposed program, and contains an appendix which summarizes the challenges that this school is designed to overcome and the benefits of opening this program for students, families, Pittsburgh Public Schools, and the city of Pittsburgh.

Relevant Board Actions

The School Board established the completion of this project as part of the Superintendent's performance based contract. There have been several relevant actions since the proposal was first reviewed by the Board at an Education committee meeting in February of 2007.

Action	Date
Board reviews preliminary proposal for the science and technology school at Education Committee Meeting	February 7, 2007
Board opens project manager position for Pittsburgh Science and Technology.	June 28, 2007
Board resolves that the Superintendent should open the Science and Technology Academy in September of 2008.	July 25, 2007
Board accepts $277,422 from the Buhl Foundation to support the development of the Pittsburgh Science and Technology Academy, "one of the key strategies in the District's High School Reform Plan to fund full-time project manager and two half-time consultants.	September 26, 2007
Board opens principal position for Pittsburgh Science and Technology.	September 26, 2007
Board authorizes contract with Foreman Group for "on-call" architectural design services for the preliminary phase or the High School Reform projects.	November, 14, 2007
Board approves agreement with Necia Hobbes for the integration, organization, and solicitation of recommendations necessary to create the curricular framework for the science and technology program.	February 27, 2008
Board approves Letter of Intent with Carnegie Museums to complete a Feasibility study and explore potential construction on the North Shore.	February 27, 2008
Board approves change of opening date for the school from September 2008 to September 2009.	February 27, 2008
Board approves contract with communications consultants Ed Barr and Chris Labash to create a communications package that will support the introduction of the Science and Technology program to the community in August of 2008.	March 26, 2008

Legislative Committee on Education Action, September 26, 2007

Acceptance of $277,422 from The Buhl Foundation to support the development of the Pittsburgh Science and Technology Academy (PSTA), one of the key strategies in the District's High School Reform Plan. Specifically, funding will support the costs of one full-time project manager for PSTA and two half-time consultants who will take recommendations developed around PSTA and turn them into a bona fide clear, actionable implementation plan. The Project Director will be held accountable for ensuring the plan is implemented smoothly as intended according to the timeline that will be developed. Areas to be mapped out for implementation include, but are not limited to:

- Curriculum
- Graduation Requirements
- Science Concentrations
- Mixed Grade Level Groupings
- Technology Integration
- Using Time Creatively to Support Authentic Learning and Development; i.e.,
- Accelerated Graduation,
- Extended Day, Extended Year,
- Block Scheduling,
- Mini, Semester, Year Long Courses
- Admissions
- Transportation
- Physical Location and Physical Start-up of High School
- Organizational Structure: i.e., Calendar Year Details, Staffing Plan, Team Structure
- Project Methods
- Resources and Public/Private Partnerships
- Career Development Aspects: Externships, Mentoring, Job Shadowing, Job Placement
- Post-secondary Training Placement
- Spaces for Success: Professional Development, Parent and Career Centers

The funding period shall run from September 27, 2007 to September 30, 2009.

Calendar of Accomplishments

Month	Major Accomplishments
July, 2007	
August, 2007	Created a comprehensive implementation calendar and project plan with tasks and dates for decisions and deliverables; Expanded the original PST design to accommodate the integration of a 6-8 cohort; Formed and engaged the Steering Committee in the planning process;
September, 2007	Aligned our design with the District strategy to provide additional support in the 6th, 9th, and 12th grades; Revised the Executive Level and solidified our definition of advanced coursework; Published series of white papers explaining the need for a scitech program, the challenges it should be designed to overcome, and the theory of how and why this school would overcome these challenges; Held focus groups with community experts and stakeholders; Held community forum at Reizenstein with A+ Schools;
October, 2007	Identified categories for potential community partnerships and developed a strategy for communicating our partnership needs; Finalized the decision to align the program, its units, and its lessons with the learning stages of Curiosity, Knowledge, and Application;
November, 2007	Engaged Frick architects in preliminary facilities plan for Frick; Conducted a facilities walk with the Steering Committee; Finalized selection of academic concentrations and names: Body and Behavior, Computers and Connections, Environment and Energy, Form and Function; Presentation and discussion with EFA Parent Committee
January, 2008	Held 1/2 day retreat with Steering Committee and PPS Leadership at the Union Project in East Liberty; Completed first draft of Frick floor plans in partnership with the architects; Began working with the Carnegie Museums of Pittsburgh on a Feasibility Study related to new construction;
February, 2008	Published web page including the opportunity for teacher and staff input; Obtained Board Approval to hire Necia Hobbes for the integration of expert input and creation of curriculum framework;
March, 2008	Aligned plan with Western PA Regional STEM Initiative for Governor's Office and PA Dept. of Ed. and joined this working team; Initiated principal hiring process with a timeline designed to hire principal in June, 2008; Held information sessions with PPS math, science, and language teachers, ITLs, and curriculum supervisors; Created a comprehensive "Resource Guide for Curriculum Design" to guide the work of contractors and future contractors; Established Curriculum Development Advisory Subcommittee of Steering Committee and scheduled meetings; Presentation to full District Office staff; Hired Ed Barr and Chris Labach, communications consultants to help us develop a strategy for communicating this program to diverse audiences;
April, 2008	Worked with state officials in Harrisburgh including Science Supervisor Stephen Dear and presented to a group including the State Secretary of Ed. Gerald Zahorchak: Completed revised six-year program budget including hiring timeline; Discussed integration of Career and Technical Education (CTE) with state director of CTE programs Lee Burkett; Developed Dream. Discover. Design. as a way to communicate the innovations in the program, and scaled back the proposal to consist of five core innovations; Conducted first round of principal phone interviews with 12 candidates; Provided the technology department with the initial scope of work for our proposed admissions process in order to simulate and gather data; Submitted Letter of Support for Pittsburgh Science of Learning Center funding renewal, a partnership that would bring significant resources to the school in its first years of operation;

School Visits and Influential Schools

Thomas Jefferson H.S. For Science and Technology

Principal: Dr. Evan Glazer
6560 Braddock Road, Alexandria, VA, 22312
(703) 750-8300
April 11, 2008

Established in 1985 as a partnership between the business community and the Fairfax County Public Schools, Thomas Jefferson High School for Science and Technology is a selective Fairfax County, Virginia public school and a Magnet Governor's Regional School for Science and Technology offering an academic emphasis in the sciences, mathematics, and technology. There are approximately 450 students per grade in grades 9-12 for a total population of about 1800. Students must have passed Algebra 1 or a higher level math course in the eighth in order to apply. There is a $90 dollar application fee ($25 for students eligible for free or reduced lunch) and students are selected based on their performance on the Thomas Jefferson Admissions Test. The standardized admissions test also includes a writing sample. Admissions are based on admission test scores, academic achievement, personal essays, and teacher recommendations.

CURRICULUM

All courses are taught at the gifted, honors, AP or Post-AP level.

Most of the core curriculum is district curriculum (enriched by TJ teachers), with some more advanced courses added in (these are created and taught by TJ teachers as well). Math starts with Algebra 2. All students learn statistics (integrated into math and science) and computer programming. The school has so many requirements that most students have only one or two electives.

Courses include Integrated Courses, English, Fine Arts (Art, Music, Theatre Arts), Foreign Language (Chinese, German, Russian, Spanish, French, Japanese and Latin), Health and Physical Education, Mathematics and Computer Science, Computer Science, Science and Technology, Astronomy, Biology, Chemistry, Geosystems, Physics, Engineering, Materials Science, Electronics, Design, Robotics, Video, Science and Technology Research Laboratories, Mentorship Program, and Social Studies (see the Course Selection Guide for details)

Specialized TJ curriculum includes:

1. Integrated Courses

- *Integrated Biology, English, Design and Technology (IBET)* – A required course during the 9th grade year, a cohort of students share the same Biology, English, and Technology teachers. They spend 80% of the course time doing work specific to each class and 20% of the course doing interdisciplinary explorations and integrated assignments. The three teachers have common planning time. The IBET program culminates in a team research project and formal symposium which provides foundation skills for the similar, but more intensive experience they will undergo in TechLabs their senior year.

- *Humanities I: English 10 and World History and Geography II*
- *Humanities II: English 11 and US History*
- *Humanities II: English 11 and AP US/VA History*
- *Topics in Globalization* - AP English (Language and Composition) and AP Government
- *Senior Seminar: Language Power and Politics* - AP English (literature and composition) and AP US Government and Politics

2. GeoSciences course

3. Science and Technology Research Laboratories

- *Tech Lab* – The program's culminating senior year experience is an intensive team structured research project. Students complete their project in an outside mentorship or work onsite. Students choose from one of twelve labs, and must apply with an essay explaining what ideas they have that make that specific tech lab necessary for what they want to do. Although there are no concentrations, tracks or majors prior to the tech labs, some labs require prerequisites. In order to take these labs, students must plan from their first year how they will fit those prerequisites into the schedule. The Tech Research Labs are:

Astronomy and Astrophysics	Microelectronics
Automation and Robotics	Oceanography and Geosystems
Biotechnology	Chemical Analysis
Optics and Modern Physics	Computer Assisted Drawing
Prototyping and Engineering Materials	Computer Systems
Emerging Technologies	Neuroscience Research Lab

4. Mentorship Program

5. 8th Periods Activities

- *8th Period Activity Period* – Every Wednesday and Friday eighth period is an activity period. Teachers offer a myriad of different activities from Study Hall, to The

Simpsons, to the Optimist Club. Students sign up for activities through a computerized system. An activities department within the school monitors this time.

LABS AND EQUIPMENT

- Twelve science and technology research labs, one for each of the senior tech lab experiences.
- The school has the equipment to produce posters and students present their research on professional quality posters.
- Labs are sponsored by businesses and plaques indicate this contribution.
- Teachers write grants, solicit donations from suppliers, visit the NIH Warehouse, university labs for used equipment
- Partnership Fund raises money for equipment
- TJ has it's own supercomputer a CRAY VI maintained by the students

LIBRARY

- The library spends most of it funds on database subscriptions. Databases are set up so that students can proxy in from home.

TEACHING/ACADEMIC PROGRAM

- *Additional graduation requirements* - TJ has graduation requirements "above and beyond" other District schools and students who enter the program commit to pursuing a special Thomas Jefferson diploma.
- *Integrated Social Studies and English at grades 10 & 11 –*
- *Tech Lab* – A

GRADUATION REQUIREMENTS

1. 4 math credits, algebra I prior to admission, math terminating with an AP Calculus
2. 4-year science, Biology (IBET), Chemistry, Physics, Geosystems
3. 4 technology credits, IBET, computer science, senior research and one elective in science, math or technology
4. 4 credits in English
5. 4 credits in Social Studies
6. 3 credits in the same foreign language
7. 2 credits in Health and Phys ed
8. 1 credit in Fine Arts/Practical Arts/Cultural Studies

26 Credits

SCHEDULING

- *Long term scheduling* - Students start the outline of their entire four year schedule when they enter the program. They say that "their whole life is scheduled from the beginning". Guidance counselors are very involved in their whole process, according to students "they play a far bigger role than they do at other schools."
- *Later start time* – The school day starts at 8:30am instead of 7:30 like other District high schools to give students coming from far away more time to get to school. It ends at 3:50.
- *Seven period day* – The academic schedule consists of seven periods plus an activity period on Wednesdays and Fridays.
- *Activity period* – Every Wednesday and Friday eighth period is an activity period. Teachers offer a myriad of different activities from Study Hall, to The Simpsons, to the Optimist Club. Students sign up for activities through a computerized system. An activities department within the school monitors this time.
- *Late start on Thursdays* – Every Thursday school starts late to provide common planning time for teachers.

FUNDING

- Teachers are encouraged to write grants and bring in outside funds as part of their job descriptions.
- An independent 501c3 has its own Director and staff. It was started by the PTSA. The organization raises funds and makes donations to the school. The TJ Partnership Fund
- Additional funds are utilized primarily to support additional teachers necessary to implement the program. **They have 15 more teachers than they would have under the normal district funding ratio**.
- The Interdisciplinary nature of the teaching requires one period per day of team planning time
- Funding supports teachers' work during the summer.

SCIENCE SEQUENCE

TJ is viewed as a normal high school with a lot of science and technology electives and a wider range of math.

"CIRPSICSR"

The guiding principles of the program (what TJ wants their students to look like upon graduation):

- Critical inquiry and research;
- Problem solving;
- Intellectual Curiosity; and
- Social Responsibility.

LEADERSHIP AND HISTORY

The school's first graduating class in the 1970s had a special role in developing the program, designing the symbols etc. that still represent the program.

ADMISSIONS

The school admits students based on proficiency according to standardized test scores. Additionally, students must have completed Algebra 1 prior to entering as a freshman at TJ.
Admissions are based on aptitude and interest which is measured by admission test scores, academic achievement, personal essays, and teacher recommendations.

Judith.Howard@fcps.edu

DEMOGRAPHICS

The school's student population is not reflective of the population demographics in the school district. African-American and Latino students are underrepresented. The school is going through a process to identify the reasons for this, including the factors that affect some students' decisions not to attend the school after they have been accepted.

There are overseas students that participate in a virtual school through the Jefferson Overseas Schools Technology Institute (JOSTI).

PROFESSIONAL DEVELOPMENT

School administrators emphasized that they have sacrificed a lot of time and funding for professional development. Their philosophy is that the teachers' role is to facilitate student-learning and let students lead the way, rather than trying to be "keepers of all knowledge".

INFORMATION HANDOUTS from the tour

Student Services Handbook
Course Selection Guide
Governor's School Brochure (20 pages)
TJ Today the student newspaper (20 pages)
Overview document
- Mission
- Goals
- Instructional Programs
- Admissions
- IBET
- Mentorship FAQs
- The TJ Experience - the Tech Labs
- Flow Chart of Math courses

Baltimore Polytechnic Institute

Principal: Dr. Barney Wilson, (Carnegie Mellon Alum)
1400 W. Cold Spring Lane, Baltimore, MD 21209
(410) 396-7026
April 14, 2008

Baltimore Polytechnic is a 9th through 12th grade school in Baltimore, MD with 1350 students. Current enrollment is 78 percent African-American and evenly split between boys and girls. On March 27, 2008 the school was featured in Education Week in an article titled “A School Where STEM is King”.[86]

Highlights

- *The Poly Foundation* – A 501c3 with a full time director and staff is housed within the school. The Poly Foundation accepts money primarily from alumni and disperses it based on formal requests from Poly faculty. The existence of the Foundation creates a simple process for teachers to access small grants for Robotics competitions or computer upgrades. It also makes it very easy for donors to give to the school. Additionally, teachers are encouraged to write grants to other Foundations.

- *The Science Research Practicum* – Students who choose the science concentration can choose to participate in the two year practicum course. This consists of a continuous and individualized two year research project conducted under the mentorship of an industry or university researcher. Students become specialists in a very specific area but the skills and experience they acquire are transferable to anything else they may choose to experience.

- *The Ingenuity Project* – Established as a 501c3 with the goal of having students recognized by the Intel Science Talent Search (formerly the Westinghouse)

- *Academic concentrations* - Students choose between a Science or Engineering concentration at upper levels –

- *An Interdiscplinary Approach* – Particularly emphasizing the relationship between art and science.

LEADERSHIP

- Bounded rationality and the principal of navigational change – You will never all all the information so it is best at a certain point to get moving in a certain direction and modify as you go.
- Great leaders seldom seek permission

[86] Trotter, Andrew, A School Where STEM Is King, Education Week Online, March 27, 2008, http://www.edweek.org/ew/articles/2008/03/27/30elite.h27.html

- The Principal as entrepreneur
- We need to have a contract with parents and students committing them to the extra year if they need it and increased graduation requirements.
- You must create an environment in which it is cool to be smart.

LABS

- The labs are HUGE open spaces put together piece by piece – not with one big even painted by the principal himself in some cases.
- Aeronautics – A flexible lab put together for $30,000 than expanded to include flight simulators. Students learn by doing in their freshman year with no prerequisites to get them excited. Then they acquire the physics and math skills before taking AP Aerodynamics in their senior year with the goal next year of launching a 4*4 satellite into space.
- Animation/Audio Recording/Sound Engineering and Production
- Robart – Robotics and Art – includes an art gallery. *One Robotics competition can cost as much as $10,000 to participate in.
- Anatomy, Physiology, Genetics, Forensics, and AP Psychology

TEACHING/ACADEMIC PROGRAM

- The whole program is honors level with three different levels of honors:
    - College Prep;
    - Advanced College Prep: and
    - The Ingenuity Project.
- They give all required exams early to get them out of the way
- Every teacher has 2 planning periods out of 8 period day
- Teachers are observed teaching lessons before they are hired
- There are teachers teaching out of content area but as long as 51% of their courseload is within content area they are legally OK, and as long as they are motivators and good classroom managers they are fine.
- All three leaders agree that self-paced math courses would be a good fit for our school.

SCHEDULING

- 8 period day – 46 minute periods per day – “This is something that we have struggled and struggled with because the short periods do make it very hard to do labs etc. but we are resigned to it for now. It will be much easier for you to do something different since you are starting new and not trying to change an existing schedule.”
-

THE POLY FOUNDATION

- 501c3 of the alumni association
- Full time Director and Staff housed within the school
- Fixed channels of communication for teachers to apply for funding

- “Make it easy for someone to give you a refrigerator.”

THE INGENUITY PROJECT

- 501c3 funded partly by Foundations and partly by the District

SCIENCE SEQUENCE

- 9^{th} grade – Biology 1 with a molecular focus
- 9^{th} grade – Project based yearlong engineering course
- 10^{th} grade – Chemistry with Algebra as a prerequisite
- 11^{th} grade – Physics with Trig/Geometry as prerequisite
- *Chem and Physics are spread out across three semesters instead of two. In 12^{th} grade students complete the third part of the chemistry and 3^{rd} part of the physics.
- The Ingenuity Project has a modified sequence because of the high level of Algebra skills students bring into the program. It also has three PhD math instructors. The Survey Math Course taught during their second year requires that students prove a theorem and formally present it to the class – important for the extremely high level of research they will do during the next two years.
- FULL YEAR Intro to Engineering Course during the Freshman year.

EMPHASIS ON SYMBOLISM, HISTORY, AND DESIGN

- According to Dr. Wilson the appearance of the school, the professionalism of the students (characterized by uniforms) the school song, the ring…all of them send a message about the prestige and character of the program.
- Six words are reinforced each Monday and Friday:
    - (Freedom and Responsibility)
    - (Goodness and Mercy)
    - (Perseverance and Achievement)

PARTNERSHIPS

- Dr. Wilson believes that the key to partnerships are making them small and specific. He says “Make it easy for someone to give you a refrigerator.”

MARKETING

- Have shadowing days, orientations, parent *and community* open houses
- Reach out to 5^{th} grade teachers
- Ingenuity Project sends a brochure home called “What every 5^{th} grade parent should know.”

City High Charter School

Founder and Education Manager: Mr. Mario Zinga
The New Clark Building
717 Liberty Ave. 9th Floor
Pittsburgh, PA 15222
September 10th, 2007

City Charter High School (City High), located in the Clark Building in downtown Pittsburgh, is currently in its sixth year of operation. The school obtained its initial five year charter in 2002 from the Pittsburgh Public Schools and was recently re-chartered through 2012. City Charter High School, which is incorporated as a 501(c)(3) non-profit organization, is governed by a nine member Board of Trustees. The school is free and open to the public. Funding is provided to the school from the students' school districts of residence.

City High serves approximately 520 ninth, tenth, eleventh and twelfth grade students. 81% of the students are from the Pittsburgh School district; the rest are from 23 area school districts. The majority of the students previously attended their assigned neighborhood public schools; remaining students attended other charter schools, magnets, parochial schools, private schools or were home schooled.

The demographics of the student population are balanced: White Males (21.6%), White Females (20.4%), African-American Males (24.4%), African-American Females (31.5%), Other (2.1%). 60% of the students have low SES as measured by the federal free and reduced lunch program. 11% of the student body receive special education services. Data collected from new 9th graders through the EXPLORE national standardized assessment suggests that City High's student body is average in ability. Students' mean national percentile ranking in terms of the composite score (comprising 6 subject area tests) is slightly less than the national norm.

The information above is taken from City High Charter School Executive Summary available through the webpage: www.cityhigh.org

Highlights:

- Looping: Teachers follow students all the way through their program.
- Career preparation sequence includes courses and a 130 hour internship.
- Every student develops their own academic and career plan.
- Certifications: Students receive Microsoft certifications through the technology courses.
- Lap-top program – each student has their own laptop with wireless Internet access.

- Trimesters: 13 week trimester cycle with core courses spanning two of the three trimesters. Year-round school.
- Pennsylvania Chapter 4 academic standards are clustered, rather than addressed individually in a traditional scope and sequence.
- Teacher offices: Every floor has a suite of teacher offices so that teachers don't "live in their classrooms".
- "The only way to get to team teaching is to actually have big rooms."
- Team taught courses: Some classes take place in a very large space with 50 students and multiple adults working with them.
- Teacher promotion schedule: Based on performance and completion of specific development requirements. Teachers go from Apprentice to Journeyman to Expert.

Notes

It took City High four years to build the culture and confidence necessary to attract students from across the board including those with a range of educational and economic options.
Marketing is done through a PR firm who responded to an RFP.
The internship program, the computer and technology repair program and the art technology programs really differentiate the school.
Admissions is simply first come, first serve.
The school does not accept students after 10th grade.
Teachers are looped with their kids all the way through.
They use only credentialed teachers.
Some classes are team taught with large groups of kids in open classrooms. Others are taught in more traditional spaces.
Teachers have a promotion schedule that is based on performance and the completion of certain specific development requirements: They go from (1) Apprentice to (2) Journeyman to (3) Expert to (4) Master.

9-10 is considered the Lower School.
- 3 blocks
- History and English together
- Math and Science together
- Technology
- Curriculum is based on whole books

*** Looping forces teachers to be learners.**

Other Influential School Visits- Non PPS

- Fox Chapel Area HS
- Quaker Valley HS
- Kennard Elementary School Gifted Program, Centreville, MD
- CEO Leadership Academy, Milwaukee, Wisconsin
- Propel Charter School, McKeesport, PA
- Denver School of Science and Technology, Denver, CO

Other Influential Schools Researched

Dozens of other schools were benchmarked and researched. These schools fall into several categories.

Categories:

- Members of the National Consortium for Specialized Secondary Schools of Mathematics, Science and Technology (NCSSSMST);
- Outstanding urban public schools including Breakthrough High Schools identified by the National Association of Secondary School Principals (NASSP);
- Comprehensive School Reform Models that have demonstrated results in impact focused program evaluation;
- Innovative public, charter, or alternative schools that have demonstrated results in impact focused program evaluation;
- Other public science and technology programs; and
- Local and regional schools.

A few of the specific schools which influenced this design but were not visited include:

- The Urban Academy, New York, NY
- High Tech High, San Diego, CA
- Talent Development HS Comprehensive School Reform Model
- Coalition of Essential Schools
- First Things First Comprehensive School Reform Model
- School Without Walls, Rochester, NY
- Science Leadership Academy, Philadelphia, PA
- University Park Campus School, Worcester, MA
- Microsoft School of the Future, Philadelphia, PA
- Centre Learning Community Charter School, State College, PA

Dozens more schools were benchmarked by the original research team and also by members of the current implementation team.

Appendices

Appendix A: Meeting Log

DATE	TIME	FACILITATOR (S)	MEETING AUDIENCE	MEETING DESCRIPTION
8/6/07	1:00pm	Sam Franklin	PFT	Information regarding Pittsburgh Science and Technology
8/20/07	11:00am	Derrick Lopez	Partners	Carnegie Mellon Partnership and Information Discussion
8/30/07	10:00am	Sam Franklin	Partners	Information and discussion at the Jewish Healthcare Foundation
8/30/07	11:00 AM	Judy Hallinen	Partners	Allegheny Singer Research Institute
9/5/07	4:30pm	Sam Franklin	Steerig Comm.	Information and feedback, 6-12 configuration
9/12/07	4:30pm	Judy Hallinen	Commun.	Focus group related to academic concentrations
9/14/07	11:00am	Judy Hallinen	Commun.	Focus group related to academic concentrations
9/18/07	6:00pm	A+ Schools	Commun.	Community forum With A+ Schools focused on Pittsburgh Science and Technology
10/1/07	12:00pm	Derrick Lopez	Partners	Meeting with Pittsburgh Technology Council
10/4/07	10:00am	Sam Franklin	School Admin.	Meeting with Carmalt administration
10/8/07	11:00am	High School Reform Team	Parents/Fam.	Discussions/survey with parents at conferences
10/9/07	4:00pm	Sam Franklin	Partners	Information and discussion session at the Allegheny Conference
10/16/07	12:00pm	Sam Franklin	Partners	Carnegie Science Center
10/17/07	12:00pm	YouthPlaces	Commun.	Meeting with afterschool providers to discuss high school reform
10/17/07	4:30pm	Sam Franklin	Steerig Comm.	Science and Technology Working Group
10/22/07	5:30pm	Sam Franklin	Partners	Meeting with Carnegie Mellon regarding communications
10/24/07	10:00am	Judy Hallinen	Partners	Meeting at the Supercomputing Center
10/25/07	8:30am	Sam Franklin	Partners	Meeting with Carnegie Science Center executives
11/5/07	8:00am	Sam Franklin	Partners	Meeting with Superintendent and Executives from Freedom Area School District in Beaver County
11/9/07	3:00pm	Sam Franklin	Steerig Comm.	Full Steering Committee for IB, External Systems, and Science and Tech Steering Committees
11/13/07	7:30am	Sam Franklin	Partners	Information session and discussion at ALCOSAN
11/13/07	12:00 PM	Judy Hallinen	Partners	Technology Collaborative Planning for PST and Robotics program
11/15/07	4:30pm	Sam Franklin	Steerig Comm.	Science and Technology Working Group
11/20/07	10:00am	Sam Franklin	Teachers	Visti to Taylor Allderdice Pre Engineering Program
12/3/07	11:30am	Sam Franklin/Judy Hallinen	Partners	Public Information Session for Professors/Staff from Carnegie Mellon University
12/4/07	1:00pm	Sam Franklin	Teachers	Visit to Perry HS
12/5/07	3:30 PM	Judy Hallinen		Technology Focus group
12/10/07	2:30 PM	Sam Franklin	Partners	Carnegie Learning meeting at CMU
12/11/07	7:30 AM	Sam Franklin	Steerig Comm.	Novice and Apprentice levels
12/13/07	3:30pm	Sam Franklin	Partners	Carnegie Science Center
12/20/07	12:00pm	Sam Franklin	Partners	Meeting with staff of LRDC at University of Pittsburgh
1/7/08	9:00 AM	Sam Franklin	Partners	Carnegie Science Center
1/8/08	4:30pm	Sam Franklin/Judy Hallinen	Steerig Comm.	External Systems Meeting focused on communication with teachers and effective use of web page
1/17/2008	1:00pm	Sam Franklin, Judy Hallinen, Michele Cheyne	Steerig Comm.	Half Day Retreat With Steering Committee and PPS Department Representatives
1/18/2008	3:00pm	Sam Franklin	School Admin.	Presentation and discussion with curriculum supervisors
1/24/2008	12:30pm	Sam Franklin, Derrick Lopez, Pete Camarda, Chris Berdnik, Vidya Patil, Rick Fellers	Partners	Meeting with Carnegie Museums of Pittsburgh focused on potential partnership
1/29/2008	2:00pm	Marsha Plotkin, Sam Franklin, Cate Reed	Teachers	Presentation and discussion with world language teachers
1/30/2008	12:30pm	Sam Franklin, Jerri Lippert, Judy Hallinen	Partners	Curriculum focused discussion with Indira Nair about the potential support and partnership with Carnegie Mellon

1/31/2008	4:00pm	Sam Franklin, Ira Weiss, Judy Hallinen, Michele Cheyne, Pete Camarda, Al Biestek, Chris Berdnik, Pete Camarda, Rick Fellers, Derrick Lopez	Partners	Carnegie Museums of Pittsburgh focused on potential partnership
2/6/2008	7:30am	Sam Franklin, Judy Hallinen, Michele Cheyne	Steerig Comm.	Steering Committee Meeting
2/7/2008	3:00pm	Sam Franklin, Chris Berdnik, Kate Bowers	Commun.	Trip to children's musuem and meeting with Jane Werner about successful PPS partnership
2/11/2008	3:30pm	Sam Franklin	Partners	Jen Stancil regarding the girl's math and science partnership
2/13/2008	4:30pm	Sam Franklin, Judy Hallinen, Michele Cheyne	Steerig Comm.	Steering Committee Meeting
2/14/2008	5:30pm	Sam Franklin	Commun.	Input session with Educational Technology Integration graduate students at Carnegie Mellon
2/18/2008	1:00pm	Sam Franklin, Mark Roosevelt, Derrick Lopez	Partners	David Hillenbrand and Carnegie Museums of Pgh Leadership Team to discuss partnership and feasibility study
2/20/2008	11:30am	Sam Franklin, Jim Lersch	Partners	U.S. Steel and their interest in improving STEM education
2/20/2008	4:00pm	Sam Franklin	Teachers	Math Teacher Information Session - Reizenstein
2/22/2008	1:00pm	Julie Stewart, Sam Franklin, Tim Aldinger (TRWIB)	Commun.	Various community agencies interested in improving education related to environmental sciences
2/26/2008	3:00pm	Sam Franklin, John Radzilowicz (CMP)	Partners	Education focused partnership with Carnegie Museums of Pittsburgh and continuation of Feasibility Study
2/27/2008	4:00pm	Sam Franklin	Teachers	Math Teacher Information Session - Reizenstein
2/28/2008	4:00pm	Sam Franklin, Rick Fellers	Partners	Carnegie Musuems of Pittsburgh - Feasibility Study
3/4/2008	4:30pm	Sam Franklin, Judy Hallinen, Michele Cheyne	Steerig Comm.	Steering Committee Meeting
3/5/2008	1:00pm	Sam Franklin, Lisa Fischetti	School Admin.	Presentation and information session for central district leadership
3/5/2008	4:00pm	Sam Franklin, Brian Corr	Teachers	Information Session for Science Teachers
3/7/2008	11:00am	Cheryl Begandy	Partners	Educational Advisory Board, Pittsburgh Supercomputing Center
3/10/2008	4:30pm	Sam Franklin, Judy Hallinen, Michele Cheyne	Steerig Comm.	Internal Systems Steering Committee Meeting
3/12/2008	4:00pm	Necia Hobbes, Sam Franklin	Steerig Comm.	Curriculum advisory subcommittee
3/17/2008	2:00pm	Necia Hobbes, Sam Franklin	Commun.	Visit to the Falk School
3/18/2008	11:30am	Julie Stewart	Commun.	Career and Technical Education Community Forum
3/20/2008	12:00pm	Sam Franklin	Partners	Presention/IDiscussion PIER Edbag at CMU
3/21/2008	11:00am	Sam Franklin, Necia Hobbes	Partners	CMU - Pittsburgh Science of Learning Center
3/24/2008	10:00am	Barry Nathan, Sue Mukherjee (PDE)	Commun.	Regional STEM Initiative
3/24/2008	4:00pm	Necia Hobbes, Sam Franklin	Steerig Comm.	Curriculum advisory subcommittee
3/28/2008	2:00pm	Necia Hobbes, Sam Franklin, Twila Simmons-Walker (ALCOSAN)	Partners	Tour of ALCOSAN facilities and overview of educational partnership opportunites
1-Apr	3:00pm	Sam Franklin, John Radzilowicz (CMP)	Partners	Education focused partnership with Carnegie Museums of Pittsburgh
4/4/2008	12:00pm	Sam Franklin, Necia Hobbes	Commun.	Science Fair - Heinz Field
4/7/2008	4:00pm	Necia Hobbes, Sam Franklin, Judy Hallinen	Steerig Comm.	Curriculum advisory subcommittee
4/9/2008	9:30am	Sam Franklin	Commun.	Michele Zuckerman, Allegheny Singer Research

4/10/2008	4:30pm	Sam Franklin, Judy Hallinen, Michele Cheyne	Steerig Comm.	External Systems Steering Committee
4/11/2008	8:00am	Judy Hallinen, Sam Franklin, Necia Hobbes	Steerig Comm.	Visit to Thomas Jefferson High School in Alexandria, VA with Steering Committee Members David Malehorn and Cheryl Telmer and Melanie Brown from the Heinz Endowments
4/14/2008	8:00am	Sam Franklin	Commun.	Visit to Baltimore Polytechnic High School, Baltimore, MD with Barney Wilson, School Principal CMU Alum
4/17/2008	4:00pm	Sam Franklin, Brian Corr	Teachers	Info Session and Discussion with Science ITLs
4/22/2008	2:00pm	Sam Franklin, Judy Hallinen, Necia Hobbes	School Admin.	Steven Dear, Pittsburgh Department of Education, Science Coordinator
4/23/2008	10:30am	Sam Franklin, Necia Hobbes	Commun.	Pennsylvania Department of Education, Governor's STEM Initiative Presentation
4/23/2008	2:00pm	Sam Franklin, Necia Hobbes	School Admin.	Marion Echols-Clark, School Services, Pennsylvania Department of Education
4/23/2008	3:00pm	Sam Franklin, Necia Hobbes	School Admin.	Lee Burkett, State Director of Career and Technical Education
4/24/2008	4:30pm	Sam Franklin, Judy Hallinen, Michele Cheyne	Steerig Comm.	Internal Systems Steering Committee Meeting
4/25/2008	3:30pm	Sam Franklin, Necia Hobbes	Partners	Carnegie Musuems of Pittsburgh - Education Partnership
5/2/2008	8:30am	Necia Hobbes	Partners	Catalyst Connections
5/5/2008	4:00pm	Necia Hobbes	Curriculum Advisory	Curriculum Advisory Committee and Other PPS Teachers
5/8/2008	4:00pm	Sam Franklin	Steering Committee	External Systems Advisory Committee
5/12/2008	4:00pm	Necia Hobbes	Curriculum Advisory	Curriculum Advisory Committee
5/27/2008	4:00pm	Necia Hobbes	Curriculum Advisory	Curriculum Advisory Committee
5/29/2008	8:00am	EPLC	Commun.	Education Policy Forum: STEM Education
5/29/2008	5:30pm	Sam Franklin	Commun.	A+ Schools Community Forum
5/30/2008	4:00pm	Sam Franklin	Steering Committee	Internal Systems Steering Committee Meeting

Appendix B: Contributor List

People who have been consulted for the design / development of Pittsburgh Science and Technology

			Advisor	Advisory Board 2006-07	Steering Committee	Graduate Research Team	Other Committee	Other
Jeffrey	Alex	H. John Heinz III School of Public Policy and Management				x		
Tim	Aldinger	Three Rivers Workforce Investment Board						x
Ron	Baille	Carnegie Science Center, Carnegie Museums of Pittsburgh					x	
Barbara	Barnes	UPMC						x
David	Bivins	Engineer, PPG			x			
Ed	Barr	H. John Heinz III School of Public Policy and Management	x					
Evan	Bass	Math Teacher, Oakland Unified School District, Oakland, CA						x
Donna	Baxter	SoulPITT			x			
Cheryl	Begandy	Pittsburgh Supercomputing Center			x			
Steve	Biancaniello	Duquesne University					x	x
David	Bivens	PPG						
Diasmere	Bloe	Jewish Healthcare Foundation						x
Lenore	Blum	Carnegie Mellon - Computer Science	x					
Melanie	Brown	Heinz Endowments						x
Meredith	Bruner	Student Achievement Center, Math and Instructional Technology, PPS						x
Randy	Bryant	Carnegie Mellon - Computer Science						
Nancy	Bunt	Allegheny Intermediate Unit, Math and Science Collaborative						x
Amy	Burkert	Carnegie Mellon - Biology	x					
Esther	Bush	Urban League of Pittsburgh		x				
Jen	Cartier	University of Pittsburgh					x	
Anna	Chin	Oakland Unified School District, Oakland, CA						x
Michele	Cheyne	University of Pittsburgh - Education						
C Dianne	Colbert	University of Pittsburgh - Investing NOW						x
Sarah	Coon	Learning Research & Development Center, University of Pittsburgh						x
Tom	Cortina	Carnegie Mellon - Computer Science	x					
Winford	Craig	Urban League of Pittsburgh			x			
Steven	Dear	Science Advisor, PA Department of Education						x
Scott	Dietz	Catalyst Connection		x				x
Carrie	Doonan	Carnegie Mellon - Biology						x
Jane	Downing	The Pittsburgh Foundation		x				
Justin	Driscoll	Pittsburgh Technology Council						x
Dolly	Ellenberg	VP of Development, Carnegie Museums of Pittsburgh					x	
Winston	Erevellas	Robert Morris, Dean of School of Engineering, Mathematics, and Science						x
Helen	Faison	Pittsburgh Teachers Institute, Chatham College		x				
Susan	Finger	Carnegie Mellon - Civil Engineering	x					
Tom	Flaherty	Director, Exhibits, Facilities, & Operations, Carnegie Science Center					x	
Sam	Franklin	H. John Heinz III School of Public Policy and Management				x		
Carol	Fuller	Project Manager for Capital Projects, Carnegie Museums of Pittsburgh					x	
Christine	Gabriel	Heinz Endowments	x					
George	Gensure	Pittsburgh Federation of Teachers			x			
Kunal	Ghosh	Carnegie Mellon - Physics	x					

Brian	Gill	RAND Corporation		x				
Terri	Gleuck	Innovation Works						x
Joe	Grabowski	University of Pittsburgh - Chemistry			x		x	
Tonya	Groover	University of Pittsburgh - Technology Leadership Institute			x		x	
Diane	Grzybek	Division of Education, Carnegie Museum of Natural History					x	
Norton	Gusky	Fox Chapel Area School District		x				
Robert	Gutierrez	H. John Heinz III School of Public Policy and Management						
		Institute of International Education				x		
Lareese	Hall	Project Manager, EcoExperience, Carnegie Science Center					x	
Judith	Hallinen	Carnegie Mellon - Educational Outreach						
Carey	Harris	Executive Director, A+ Schools						x
Christy	Heid	Chatham University			x			
Keith	Hartranft	Northampton Community College						x
William	Heilman	Pittsburgh High School for the Creative & Performing Arts						x
Ed	Henke	Pittsburgh Public School Teacher - Physics					x	
Keith	Hinderlie	SEED School Former Director of Programs						x
Ruth	Howse	Parent						x
Gabi	Hughes	Audobon Society of Western Pennsylvania						x
Mario	Iasella	Schenley High School, Pittsburgh Public Schools - Physics	x					
Mark	Inglis	Denver School of Science and Technology						x
Pallavi	Ishwad	Pittsburgh Supercomputing Center						x
Rebekah	Jenkins	A+ Schools						x
Michael	Johnson	H. John Heinz III School of Public Policy and Management	x	x				
Neil	Jones	Western Pyschiatric Institute and Clinic						x
Rufus	Jordan	Pittsburgh Federation of Teachers		x				
David	Klahr	Carnegie Mellon - Psychology			x			
Terri	Knaebel	Sterret Classical Academy, 6th Grade Science					x	
Ken	Koedinger	Pittsburgh Science of Learning Center			x		x	
Jane	Konrad	Pittsburgh Regional Center for Science Teachers						x
David	Kosbie	Carnegie Mellon - Computer Science	x					x
Cheryl	Kubelick	Buhl Foundation			x			
Chris	Labash	H. John Heinz III School of Public Policy and Management	x					
Justin	Laing	Heinz Endowments						x
Erica	Lamar	ALCOSAN						
Jeff	Laurenson	Brashear High School, Pittsburgh Public Schools						x
Marianne	LeDonne	Regional Choice Initiative						
Jessica	Lausch	Carnegie Science Center - Director of Education Experience						x
Paul	Leger	Allegheny Conference	x					
Jan	Leight	Focus on Results						x
Ken	Leitisco	University of Pittsburgh - Child Development						
Cornell	Lesane	Carnegie Mellon - Admissions			x			
Alan	Lesgold	University of Pittsburgh - Education		x	x			
Gordon	Lewis	H. John Heinz III School of Public Policy and Management	x	x				
Junlei	Li	University of Pittsburgh - Child Development			x			
Barry	Luokkala	Carnegie Mellon - Physics	x					
David	Malehorn	Parent			x			
Jean-Anne	Matter	PNC	x					
Deanna	Matthews	Carnegie Mellon - Civil Engineering						x

Nina	Mayfield	Westinghouse HS Mathematics							x
Margaret	McDonald	University of Pittsburgh Health Sciences							
Wendell	McConnaha	Director, Falk Laboratory School							x
Martin	McGuinn	Former CEO, Mellon Financial Corp.	x	x					
Barbara	McNees	Allegheny Conference on Community Development & Affiliates		x					
Stephen	Mitchell	Allegheny Conference on Community Development		x					
Cynthia	Morton	Head of Botany/Assoc. Curator, Carnegie Museum of Natural History					x		
Franklin	Moore	National Society of Black Engineers							x
Rob	Moore	Engineer							x
Tracy	Myers	Curator of Architecture, Carnegie Museum of Art					x		
Sue	Mukherjee	Special Assistant to the Secretary, Pennsylvania Department of Education,							
		Pennsylvania STEM Initiative							x
Indira	Nair	Carnegie Mellon - Office of the Provost			x				
Barry	Nathan	Catalyst Connection	x						
Carmelle	Nickens	Urban League of Pittsburgh		x	x				
Liz	Nilsen								x
Genevieve	Nolan	H. John Heinz III School of Public Policy and Management				x			
		Senior Research Associate, The Civic Federation							
Linda	Ortenzo	Carnegie Science Center - SciTech Spectacular							x
Don	Osterwise	Manager of Strategic Sourcing, Carnegie Museums of Pittsburgh					x		
Ron	Painter	Three Rivers Workforce Investment Board			x				
Jordan	Pallitto	The Hill Group			x	x			
Victor	Papale	A+ Schools, Former Executive Director		x					
Steven	Pellathy								x
Ann	Pellegrini	H. John Heinz III School of Public Policy and Management, Google				x			
Alan	Puskaric	Pittsburgh Allderdice, Pittsburgh Public Schools	x				x		
John	Radzilowicz	Carnegie Museums of Pittsburgh					x		
Mick	Real	Pittsburgh Allderdice, Pittsburgh Public Schools	x				x		
Mark	Reardon	Pittsburgh Zoo and PPG Aquarium							x
Mandy	Revak	Pittsburgh Zoo and PPG Aquarium							x
Meg	Richards	Computer Science, Carnegie Mellon University	x						
Aisha	Robinson	Westinghouse HS Mathematics					x		
Nyota	Robinson	Urban League of Pittsburgh							x
Patti	Rote	Technology Collaborative	x						
Patti	Rote	Pittsburgh Technology Collaborative							
Ira	Rothstein	Carnegie Mellon - Physics	x						
Velma	Saire	Former Teacher, HeadStart Director, Principal, and Superintendent	x						
Christian	Schunn	Learning & Research Development Center, University of Pittsburgh							x
Steven	Scoville	PPS Teacher - Brashear			x				
Linda	Serody	Parent			x				x
Robin	Shoop	Carnegie Mellon - Robotics Academy	x						
Nora	Siewiorek	University of Pittsburgh							x
Twila	Simmons-Walker	ALCOSAN	x						
Chandralek	Singh	University of Pittsburgh - Physics						x	
Ron	Sofo	Freedom Area School District			x				
Jennifer	Stancil	Girls, Math & Science Partnership, Carnegie Museums of Pittsburgh							x
Mark	Stehlik	Carnegie Mellon - Computer Science							x
Elizabeth	Steiner	Jewish Healthcare Foundation			x	x			
Angie	Stokes	Children's and Family Program, Div. of Education, Carnegie Museum of Natural History							x
Joe	Stone	University of Pittsburgh - Investing NOW							x
Luanne	Stoodley	Allegheny Singer Research Institute	x						
Karen	Stump	Carnegie Mellon - Chemistry							x
Leigh Ann	Sudol	Carnegie Mellon - Computer Science							x
Klaus	Sutner	Assoc. Dean of Undergrad. Programs, Carnegie Mellon - Computer Science							x
John	Tagg	PPS Teacher - Stevens					x		
Roy	Taylor	Carnegie Mellon - Computer Science							x

Klaus	Sutner	Assoc. Dean of Undergrad. Programs, Carnegie Mellon - Computer Science					x
John	Tagg	PPS Teacher - Stevens				x	
Roy	Taylor	Carnegie Mellon - Computer Science					x
Cheryl	Telmer	Parent		x		x	
Joe	Trotter	Department of History, Carnegie Mellon University					x
Tresa	Varner	The Andy Warhol Museum, Curator of Education and Interpretation					x
Nelson	Vasconcelos	H. John Heinz III School of Public Policy and Management, Pittsburgh Public Schools			x		
Benjamin	Walker	Urban Youth Action					x
Garry	Warnock	Carnegie Mellon - Chemistry					x
Newell	Washburn	Carnegie Mellon - Chemistry	x				
Jane	Werner	Children's Museum of Pittsburgh					x
Barney	Wilson	Principal, Baltimore Polytechnic Institute					x
Ellen	Wright	PPS Teacher - Perry					x
Victoria	Yann	Southwestern PA Area Health Education Center, Inc					x
David	Yaron	Carnegie Mellon - Chemistry	x				
John	Young	Former Principal, Schenley High School				x	
Wai-Ting	Yu	H. John Heinz III School of Public Policy and Management, NYC Office of Management and Budget			x		
Minhee	Yun	University of Pittsburgh - Electrical and Computer Engineering					x
Mario	Zinga	Founder and Education Manager, City High Charter School					x
Michelle	Zuckerman	Allegheny Singer Research Institute					x

Other includes Focus Group sessions and discussions about specific pieces of the program, etc.

Appendix C: Committee Rosters

Steering Committee - External Systems Advisory		
Jordan Pallitto	The Hill Group	Industry
Benjamin Walker	Urban Youth Action	Community/Non-Profit
Linda Serody	Parent	HSR Task Force
Donna M. Baxter	SoulPitt, Technology Entrepreneur	Industry/Technology Education
Elizabeth Steiner	Jewish Healthcare Foundation	Foundation
Cornell Lesane	Carnegie Mellon U. Admissions Office	Higher Ed - Admissions
Junlei Li	University of Pittsburgh	University
Carmelle Nickens	Urban League Education	Nonprofit
Ronald Painter	CEO, Three Rivers Investment Board	HSR Task Force
Tonya R. Groover	Technology Leadership Institute - University of Pittsburgh	Nonprofit/University/CompSci
Jen Stancil	Girls, Math and Science Partnership	Nonprofit/Community

Steering Commiteee - Internal Systems Advisory		
Cheryl Telmer	Parent, Biologist	Parent/Industry
Elizabeth Steiner	Jewish Healthcare Foundation	Nonprofit
Winford Craig	Director of Technology, Urban League of Greater Pittsburgh	Community/Non-Profit
Dr. David Klahr	Professor of Cognitive Development and Education Sciences, Psych Department, CMU	Higher Ed-Psychology
Dr. Randy Bryant	Dean of School of CompSci, CMU	Higher Ed-Computer Science
Dr. Joe Grabowski	Department of Chemistry, UPitt	Higher Ed-Chemistry
Margaret C. McDonald	Associate Vice Chancellor for Academic , Health Sciences	Higher Ed-Medicine
Dr. Indira Nair	Vice Provost of Education, Carnegie Mellon University	Higher Ed-Chemistry
Ellen Wright	PPS Teacher, BioTech	PPS - Science Teacher, Perry
Steven Scoville	Pittsburgh Public Schools	PPS - Science Teacher
Linda Lane	Deputy Superintendent	PPS
Dr. Ronald Sofo	Freedom Area School District	SciTech High Schools
Jordan Pallitto	The Hill Group	Industry
David P. Bivins	Sr. Research/Development Engineer, PPG Industries, Inc.	Industry
Cheryl Kubelick	Buhl Foundation	Foundation
Tonya R. Groover	Technology Leadership Institute - University of Pittsburgh	Nonprofit/Industry/CompSci
George J. Gensure	PFT	PFT

Curriculum Advisory Subcommittee	
Necia Hobbes	Contractor
Brian Corr	PPS Curriculum Supervisor, PPS
Aisha Robinson	Westinghouse HS Mathematics
Terri Knaebel	Sterret Classical Academy, 6th grade science
Ed Henke	Science Teacher, Langley HS
John Tagg	Science Teacher, Stevens
Joe Grabowski	Chemistry, University of Pittsburgh
Ken Koedinger	School of Computer Science
Jen Cartier	University of Pittsburgh, School of Education
Cheryl Telmer	Parent, Biologist
Tonya Groover	Technology Leadership Institute, Upitt
Elizabeth Steiner	Jewish Healthcare Foundation

Appendix D: Bibliography

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