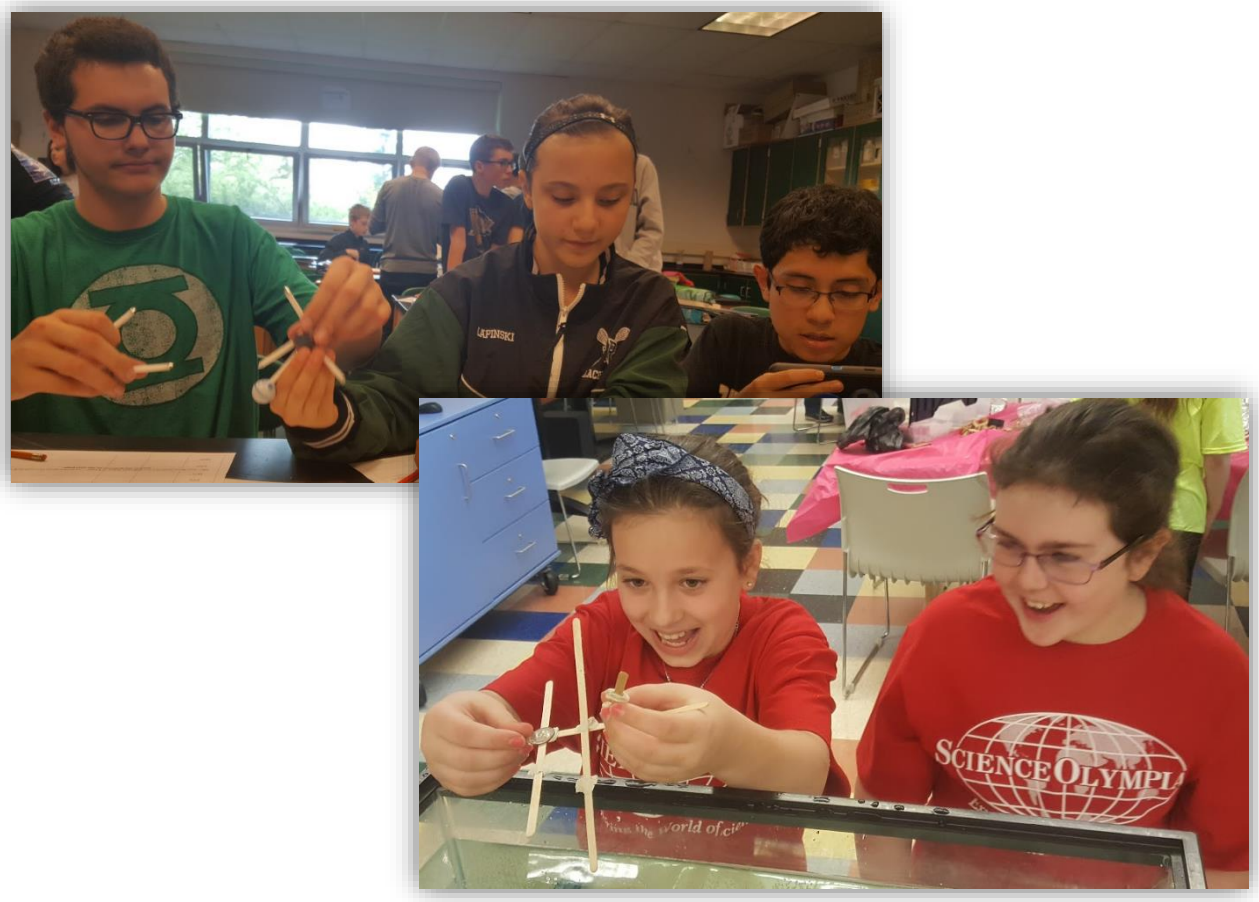

Science Department Program Review

Pine-Richland School District

May 2017

The information contained in this Report is provided by the Pine-Richland Science Department for general purposes only. While this Report serves as a strategic approach to curriculum planning, recommendations must be considered with respect to all programs provided by Pine-Richland School District.

Science Department Program Review

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Philosophy Vision Statement

Engage students in the world of science by developing a foundation of skills strengthened through a wide range of content and experiences.

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Executive Summary

The mission of the Pine-Richland School District is to *Focus on Learning for Every Student Every Day.* Within the PRSD Strategic Plan, long-term and short-term goals outlined in the Teaching and Learning category form the foundation for continuous improvement. One of the short-term goals for 2016 - 2017 was to design and pilot an in-depth program review. Further information about the purpose and process for this work is outlined in the next section.

The Science Department and Health/Physical Education Department were identified as the initial areas for further study. This report outlines the process, findings, and recommendations from that work. As an organization, it is understood that the pace of change may be dependent upon the impact of that change on other aspects of the educational program. The committee utilized the action priority matrix to evaluate each recommendation and established an implementation timeline with associated cost estimates.

One element of the in-depth program review was the establishment of a departmental philosophy and vision (Figure 1). Since science spans all six buildings in grades K - 12, it is important for students, staff, and community to understand the major focus and progression within this discipline. The vision is captured through the following image and words:

Figure 1

Engage students in the world of science by developing a foundation of skills strengthened through a wide range of experiences.

Recommendation Overview

Recommendation #1:
Adopt and widely communicate the Science Department philosophy and vision to internal and external stakeholders while ensuring a practical connection to program design and delivery.

Recommendation #2:
Modify the structure of the sixth grade program at Eden Hall Upper Elementary in order to increase time allocated to science instruction to provide greater depth of understanding within each unit of study and improve students' transition from Eden Hall Upper Elementary to Pine-Richland Middle School.

Recommendation #3:
Develop and refine a series of common assessments K-12.

- Assessments are to be varied in both type and purpose (e.g., formative, summative, traditional, and project-based).
- Assessments shall require students to demonstrate depth of knowledge at all levels and demonstrate key crosscutting skills of scientific practice.
- Analyze results collectively to look for patterns or themes in student learning that can be used to inform and drive instruction.

Recommendation #4:
Align Pine-Richland K-12 curriculum to current PA Science Standards, incorporating best practices, while emphasizing content and skills.

- Incorporate a cross-curricular approach to instruction aligned to the PA Core Academic Standards for Reading and Writing in Science and Technical Subjects, which includes reading, writing, listening, and speaking, while using empirical evidence to defend one's position.
- Determine scope and sequence of assured reading and writing experiences and revise the K-12 Science Curriculum accordingly.
- Incorporate text-dependent analysis through reading of expository texts and current journal articles into K-12 science courses.
- Incorporate documentation of scientific writing; consider using the "model" science notebook for reading, writing, analysis, etc., to reinforce a common non-fiction writing format and language (technical writing) using back-mapping of curriculum, in grades 3-12, to ensure expectations are met by grade 12.

Recommendation #5
Focus professional development in the area of scientific practices and embed specific learning goals about those practices within the unit-based curriculum (i.e., see bullet 3 below).

- Incorporate reading and writing skill instruction and source document acquisition.
- Integrate journals and periodicals to supplement instruction with appropriately leveled research (e.g., ChemMatters).
- Systematically embed scientific and engineering practices in instructional strategies throughout all K-12 science courses. Practices include:
    - Asking questions and defining problems
    - Developing and using models
    - Planning and carrying out investigations
    - Using mathematics and computational thinking
    - Analyzing and interpreting data
    - Constructing explanations and designing solutions
    - Engaging in argument from evidence
    - Obtaining, evaluating, and communicating information

Recommendation #6

Revise Science Pathways to strengthen and expand opportunities for students to be appropriately challenged in courses within each pathway. Six specific sub-recommendations for revising the Science Pathways include:

- 6a - Review and revise the every other day supplemental instruction course for students who score below proficient on the Biology Keystone Exam. The course will reinforce Biology content by focusing on crosscutting science skills (e.g. analyzing and interpreting data, constructing explanations and designing solutions, and developing and using models).
- 6b - Award science credit for students taking any course within the Pine-Richland High School Science Department pathway options beginning with the 2018-2019 school year. Biology will continue to be a required course for all students.
- 6c - Offer AP Physics C with an option for students to take the CHS Physics Exams and explore adding additional AP courses to the high school program of studies (e.g., AP Environmental or AP Physics 1).
- 6d - Determine appropriate mathematics requirements for high school science courses and rewrite course descriptions in the Program of Studies to better reflect the differences in the courses and different math expectations for the different levels.
    - Remove math prerequisites for Biology courses.
    - Revise prerequisite for Honors Chemistry to completion of Algebra 1 and teacher recommendation.
    - Revise prerequisite for Academic Chemistry to completion of Algebra 1.
- 6e - Revise science pathway options to include:
    - Biology option for all students entering 9th grade possibly with an A/B lab.
        - Open the third tier co-taught Biology course to ninth and tenth graders.
    - Remove Honors Earth and the Environment from the High School Program of studies.
    - Revise Earth and the Environment Course.
    - Examine curriculum for science courses in grades 6 - 12 to address gaps in Earth and environmental science and ensure all students (regardless of pathway) are exposed to content.
    - Remove or revise the high school Physical Science course.
    - Based on changes to 9 - 10 grade pathways, develop additional courses at the high school (e.g. Meteorology/Ocean Science, Natural Disasters, Ecology, and Geology).
- 6f - Create an additional pathway in 8th grade science by establishing a compacted/extended and current course option.

Recommendation #7

Facilitate and sustain partnerships with community connections to provide meaningful, consistent experiences across a variety of science fields.

- Coordinate field experiences and guest speakers based upon grade level standards and developmental needs of students, bringing content to life and capturing the opportunities within a shared document.
- Promote apprenticeships available to students within various fields for career exploration (e.g., AIU offerings and National Weather Service).
- Collaborate with PTOs and interested sponsors to offer afterschool programs related to the sciences, bolstering available opportunities for students to engage in science.

Recommendation #8

Continue the use of Amplify Science in grade 7 and consider extending Amplify Science opportunities into other grades.

In-Depth Program Review Process

The process for in-depth program review was developed and refined throughout the 2016 - 2017 school year. To help ensure a clear understanding of the process elements, a process diagram (figure 2) was developed and reviewed on a regular basis. Major elements of this image are further described below:

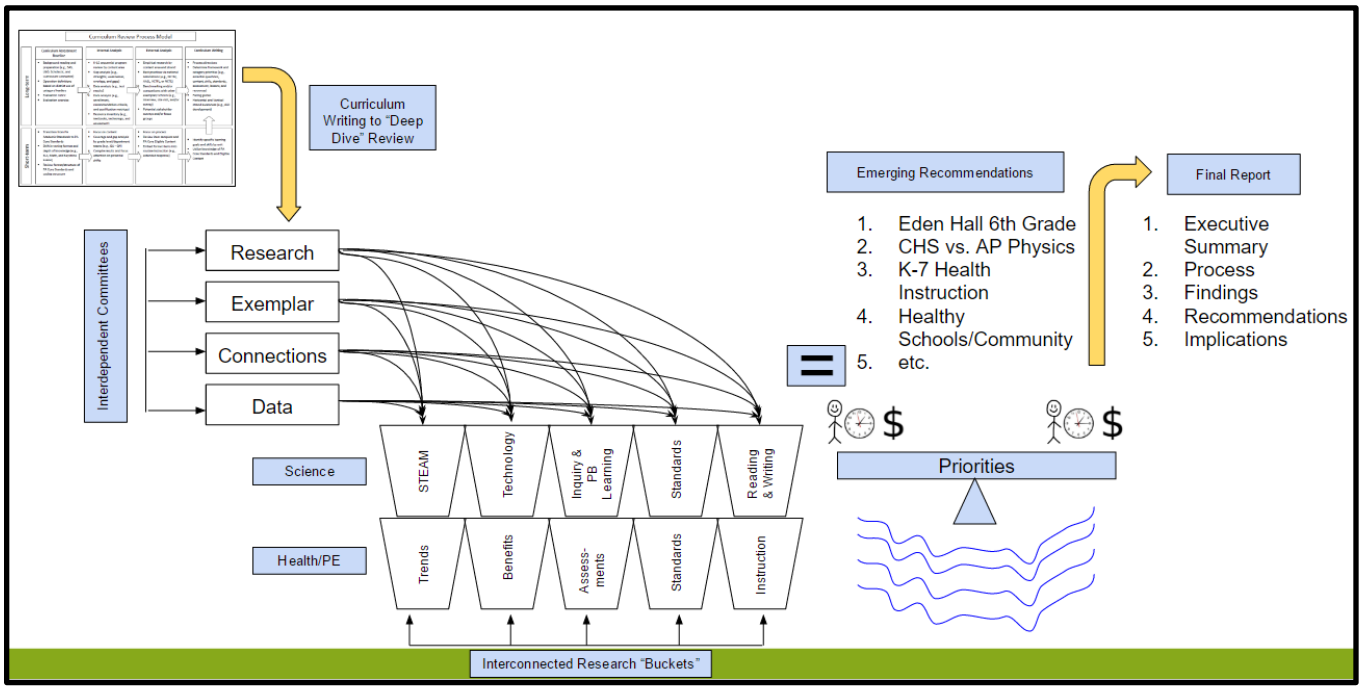

Figure 2

Curriculum Writing to "Deep Dive"

Given the time and effort invested into curriculum writing at Pine-Richland from 2014 - 2016, it is important to understand the relationship of that work to the in-depth program review process. The two-year curriculum writing process was designed to capture the current content in a consistent format through vertical teams (e.g., units, big ideas, and learning goals). That process allowed the department to identify strengths and opportunities for improvement. Most of the attention was directed internally at a review of our district's current structure and practices.

The **in-depth program review process has a broader focus** on all elements of the department. Importantly, the process was designed to emphasize a balance of internal needs and a review of best practices from external sources. It asks questions, such as, "Are we doing the right things?" or "Do we need to consider more significant changes in program design?" In the image above, the curriculum writing process is like a "springboard" to "dive" more deeply into the content area. The personnel, structure, and work was organized into four major sub-committees.

Committee Composition and Structure

We strongly believe that meaningful and lasting change requires engagement of all key stakeholders. Since the in-depth process was being developed and implemented at the same time, the first organizational decision was the use of a **core team** and an **expanded team**. The core team included several district office administrators, building principals/assistant principals based on vertical team assignment, and a small group of academic leadership council members (i.e., department chairs) and teachers. The core team conducted the planning and thinking necessary to maximize the efficiency and effectiveness of the expanded team. The expanded team included all core team members and additional teachers to ensure representation by all buildings, levels, and courses. Although this was a larger group, it was still a small representation of the overall science department.

Within the expanded team, members were then organized by **four main subcommittees**: (1) Research; (2) Exemplar K-12 Schools; (3) Connections to Universities, Businesses, and the Community; and (4) Data and Information. While each subcommittee was responsible for specific tasks, two overarching elements were critical. First, the arrows on the left side of the subcommittees indicate that the groups must collaborate and exchange information (i.e., no silos). Second, the arrows on the right side of the subcommittees demonstrate that key findings/learning were captured and organized by major research buckets.

It is important to note that the expanded teams also used a systematic approach to listen to students and parents. Student focus groups were organized at the high school, middle school, and Eden Hall. These groups were representative of the student body and a wide range of academic rigor. In addition, parent and community input was gathered during daytime and evening town hall sessions. Parents who were unable to attend those face-to-face meetings were able to submit comments electronically.

Research "Buckets"

Within each discipline, five key areas of investigation were identified to guide the work of the subcommittees. As science information was gathered by subcommittees, it was organized into five key "buckets": (1) Science Technology Engineering Art and Mathematics (STEAM); (2) Technology Integration; (3) Inquiry and Project-Based Learning (PBL); (4) Standards; and (5) Reading and Writing within the Content Area. In the early months of the process, the "buckets" were dynamic, meaning that some initial concepts were removed or combined with other key themes. As the expanded team continued to learn, those titles were then finalized. Importantly, the arrows on the bottom of the buckets also demonstrate the relationship between areas (i.e., no silos). The subcommittees' learning and identification of information for the buckets were interconnected, as information from one area informed others. Based upon the information gathered through the bucket findings, a set of emerging recommendations was developed.

Emerging Recommendations

A systems thinking approach was critical to the in-depth program review process. The transition from "findings" to "emerging recommendations" required skills of synthesis, critical thinking, healthy debate, and communication. The entire expanded team used one set of lenses to review the list of internal strengths and weaknesses. The lenses refer to the four subcommittees. Some emerging recommendations were designed to improve current gaps and weaknesses. Other emerging recommendations were identified in the analysis of exemplary programs, universities, businesses, or in the research literature. The team brainstormed recommendations by identifying recurring themes, ideas, and opportunities for growth. The team discussed, modified and edited the recommendations. Emerging recommendations were consolidated into a draft. The expanded team worked with the draft to link the emerging recommendations to data provided by the

subcommittees.

Balancing Priorities and Resources

As a system, the "ripple effect" of recommendations was built into the process model. The team then put the emerging recommendations into the action-priority matrix. The action-priority matrix (figure 3) evaluates the impact versus the effort of the emerging recommendations. Examining the use of people, time, and money allows for the identification of which recommendations were quick fixes, major projects, fill-ins, and hard slogs. For example, a hard slog was used to categorize those recommendations that would require much effort but have little impact on student learning. The team then identified the final emerging recommendations.

Action Priority Matrix

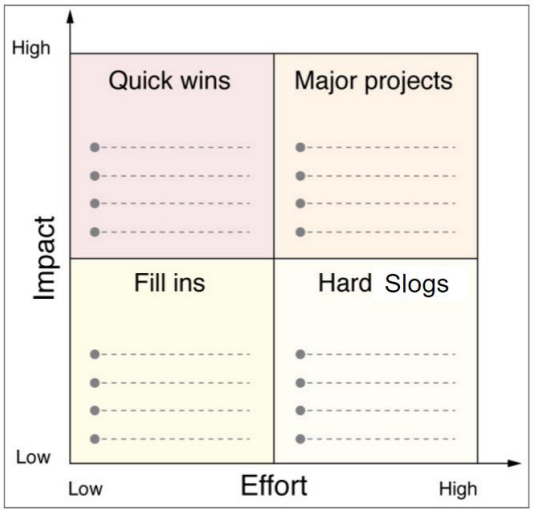

Figure 3: Elmansy, Rafiq. "Time Management Tips for Designers: The Action Priority Matrix."*Designorate*, 14 June 2016, www.designorate.com/time-management-the-action-priority-matrix/. Accessed 14 Mar. 2017.

Continuum of Improvement

Throughout the in-depth program review process, it was important to maintain perspective on the nature of program improvements. Especially when considering effective elements of exemplary schools or programs, the desire to move from the current program ("Point A") to an ideal future ("Point Z") is natural. However, it is more realistic to recognize that meaningful program improvement within an organizational system will often result from a series of smaller steps ("Points B, C, D, etc."). Although depicted as a straight line in the image below (figure 4), the in-depth program review committee recognizes that continuous improvement is not always a linear process.

Figure 4

Emerging Recommendations

Recommendation #1:
Adopt and widely communicate the Science Department philosophy and vision to internal and external stakeholders while ensuring a practical connection to program design and delivery.

Figure 5

Engage students in the world of science by developing a foundation of skills strengthened through a wide range of experiences.

FINDINGS:

Internal Analysis

1. A unifying philosophy is not currently in place (PRSD Vertical Team, 2016).
2. Parent feedback obtained during Program Review focus groups included the ideas that the best way to teach science is to ask good guiding questions, science education should teach students how to learn, students must demonstrate deep understanding, and teachers must incorporate experiences for real world, interactive problem-solving (Community Input, 2017).
3. Student feedback obtained during Program Review focus groups indicated that science is engaging when they are able to apply what they have learned, their understanding comes from hands-on experiences, and real world examples are used (Student Input, 2017).

External Analysis

1. "Deeper learning is the process through which a person becomes capable of taking what was learned in one situation and applying it to new situations - in other words, learning for transfer. Through deeper learning, students develop expertise in a particular discipline or subject area that goes beyond memorization of disparate facts or rote procedures; they also understand when, how, and why to apply

what they know. They recognize when new problems or situations are related to what they have previously learned, and they can apply their knowledge and skills to solve them" (National Research Council, 2012, p. 3).

2. Students should have more hands-on exploring, creating and troubleshooting, at the elementary level. "It is important for students to realize that science is not all about knowing all of the answers, it's constantly questioning." Students seem to be taught the product of science, but are not involved in the science itself. An educational philosophy should be constructed that has to do with the scientific process (Carnegie-Mellon University, 2017).
3. Successful employees at Pittsburgh Plate Glass (PPG) need to be able to see a problem, identify and search for solutions, implement solutions, share results, and collaborate with colleagues (PPG, 2017).
4. In summary, all universities and businesses advocate for multiple hands-on, problem-based, learning experiences. That allows for the acquisition of a particular set of skills to solve problems in and outside of the science realm (Connections, 2017).
5. Deeper learning - "meaningful learning" - "understanding of the deeper structure of problems and the methods used to solve them, enabling students to transfer their knowledge and skills to new problems. In contrast, rote learning - simply knowing facts or how to follow procedures - does not lead to transfer" (National Research Council, 2012. *Education for Life and Work).*
6. The future of science education has been described within *A Framework for K-12 Science Education*: The "overarching goal is to ensure that by the end of 12th grade, ***all*** **students** have some appreciation of the beauty and wonder of science; possess sufficient knowledge of science and engineering to engage in public discussions on related issues; are careful consumers of scientific and technological information related to their everyday lives; are able to continue to learn about science outside school; and have the skills to enter careers of their choice, including (but not limited to) careers in science, engineering and technology." (National Research Council, 2012, pp 1-2).

Implementation Timeline (Anticipated Start/Finish): 5/1/17 - 9/30/17

Key Personnel: Science Core Team Members and Director of Communications

Major Action Steps: (1) Finalize words and image; (2) Disseminate to all members of the K-12 science department; (3) Publish on district website; (4) Discuss with students and parents at the start of the 2017 - 2018 school year via syllabus and open house/curriculum nights; (5) Incorporate into published science curriculum documents; and (6) Incorporate into Programs of Studies.

Estimated Budget/Resources: There is a potential cost associated with producing posters. No other costs are anticipated.

Potential Implications (Short-Term and Long-Term): The development, understanding, and communication of a clearly articulated science department vision/philosophy should strengthen program delivery for all stakeholders (i.e., staff, students, and parents). It provides a perspective that can be reinforced and considered when making future program decisions.

Recommendation #2:
Modify the structure of the sixth grade program at Eden Hall Upper Elementary in order to increase time allocated to science instruction to provide greater depth of understanding within each unit of study and improve students' transition from Eden Hall to Pine-Richland Middle School.

FINDINGS:

Internal Analysis

1. Students in grade six participate in science instruction every other day for approximately 55 minutes (Vertical Team, 2015).
2. The sixth grade science curriculum consists of three units: Rock Cycle and Fossil Profiles, Weathering and Erosion of Rocks and Soil, and Understand Weather and Climate - Storms. Additional time allocated to science instruction will provide for greater depth of understandings within each unit (Vertical Team, 2015).
3. Teachers use textbook and online resources through McGraw-Hill iScience along with Asset Kits in an effort to develop learning activities that provide students with content knowledge and hands-on experiences (PRSD Science Curriculum, 2017).
4. The PVAAS Quintile Diagnostic Report for grade 8 demonstrates that students in the fourth quintile exceeded the growth standard and students in the second and third quintiles met the growth standard. Students in the first and fifth quintiles in grade 8 and all quintiles in grade 4 did not meet the growth standard for PSSA Science (PRSD Academic Achievement and Growth Report, 2016).
5. Parents would like to have Science every day at Eden Hall. Science is very important. From one parent's perspective, it seems like science consists of only projects instead of projects and content building on each other (Parent Input, 2017).
6. The majority of students who participated in the 6th grade focus groups shared that they would like all four classes every day (science, math, ELA, social studies). Students shared that they would like to have different teachers because they have different teaching styles (Student Input, 2017).
7. Extension of science instruction would promote the needed focus and application of text-dependent analysis across multiple content areas in standardized assessments (PRSD Academic Achievement and Growth Report, 2016).
8. Daily science instruction will strengthen the transition and student readiness for meeting the expectations of the Pine-Richland Middle School Program (PRSD Vertical Team Findings, 2016).

External Analysis

1. Exemplary science education can offer a rich context for developing many 21st-century skills, such as critical thinking, problem solving, and information literacy, especially when instruction addresses the nature of science and promotes use of science practices (National Science Teachers Association, 2016).
2. The National Science Teachers Association (2016) supports the notion that inquiry science must be a basis in the daily curriculum of every elementary school student at every grade level. Each report has highlighted the importance of early experiences in science so that students develop problem-solving skills that empower them to participate in an increasingly scientific and technological world.
3. The National Research Council (2012) anticipates that the insights gained and interests provoked from studying and engaging in the practices of science and engineering during their K-12 schooling should help students see how science and engineering are instrumental in addressing major challenges that confront society today. Examples include generating sufficient energy, preventing and treating diseases,

maintaining supplies of clean water and food, and solving the problems of global environmental change.

4. Exemplary schools investigated provide science instruction on a daily basis at the sixth grade level. (Unionville-Chadds Ford School District, North Allegheny School District, Neshaminy School District, Downingtown School District, Peters Township MS).

Implementation Timeline (Anticipated Start/Finish): 5/1/17 - 8/11/2017

Key Personnel: Eden Hall Administrators, 6th Grade Science Teachers, and Assistant Superintendents

Major Action Steps: (1) Identify team structure and scheduling configuration to determine staffing needs; (2) Modify curriculum to support science every day; (3) Assess resources to support curriculum; (4) Communicate plan to community; (5) Move teachers' classrooms to support new structure; and (6) Provide professional development to teachers.

Estimated Budget/Resources: Resource needs will be reviewed. Limited costs expected due to equal number of science sections projected. Costs associated with relocating teachers and revising/expanding curriculum through ancillary pay.

Potential Implications (Short-Term and Long-Term): It is anticipated that providing a structure similar to the middle school will better support students as they transition from Eden Hall to Pine-Richland Middle School. Additional time allocated to science instruction will assist teachers in helping students better understand key science concepts and procedures through daily practice and exploration. Students will experience an increase in time dedicated to science and social studies. While a reduction of time is noted in ELA and mathematics, RAM Time will be dedicated to those areas.

Recommendation #3:

Develop and refine a series of common assessments K-12.

- Assessments are to be varied in both type and purpose (e.g., formative, summative, traditional, and project-based).
- Assessments shall require students to demonstrate depth of knowledge at all levels and demonstrate key crosscutting skills of scientific practice.
- Analyze results collectively to look for patterns or themes in student learning that can be used to inform and drive instruction.

FINDINGS:

Internal Analysis

1. Common assessments will provide collective experiences that all students take with them to strengthen the transitions from primary to secondary programs (PRSD Vertical Team, 2016).
2. Formal assessments are rarely and inconsistently utilized in the science classroom at the primary level (PRSD Vertical Team, 2016).
3. Currently assessments are not evaluated or analyzed to identify strengths and weaknesses of instruction (PRSD Vertical Team, 2016).

External Analysis

1. Exemplary districts use common midterms and finals that focus on skills being assessed rather than rote memorization of content (UCFSD, Neshaminy School District, North Penn, Downingtown STEM Academy).
2. Educators are given opportunities to meet and analyze assessment results in order to address instructional needs prior to further assessment (UCF School District, Neshaminy School District, North Penn, Downingtown STEM Academy).
3. Allow assessments to drive curriculum, then allow curriculum to drive instruction (UCFSD, Neshaminy School District, North Penn, and Downingtown STEM Academy).
4. "Assessment must be aligned with—
    a. what is of value, i.e., the problem-solving model of instruction: concept application, inquiry, and process skills.
    b. the curricular objectives and instructional mode.
    c. the purpose for which it was intended: grading, diagnosis, student and/or parent feedback, or program evaluation" (NSTA Position Statement: Elementary School Science, 2016, pg. 1).
5. "Receiving feedback during practice is critical to acquiring a skill. Learners need feedback about the correctness of what they have done. If their work is incorrect, they need to know the nature of the mistake. Practice without feedback produces little learning" (National Research Council, 2012, pg. 2).
6. Students should learn how to draw conclusions and think critically and logically to create explanations based on their evidence and then communicate and defend their results to their peers and others (NSTA Position Statement: Scientific Inquiry, Pg. 2).
7. *A Framework for K-12 Science Education* - "Intended to guide the development of new standards that in turn guide revision to science-related curriculum, instruction, assessment, and professional development for educators" (National Research Council, 2012, pg. 2).

Implementation Timeline (Anticipated Start/Finish): 5/1/2017 - 6/1/2019

Key Personnel: K-12 Science Teachers, Administrative Liaisons to the Department, and Assistant Superintendents

Major Action Steps: (1) Establish the frequency with which common assessments will take place and create a schedule for their administration annually; (2) Develop common assessments utilizing a variety of knowledge depths and types; (3) Create a shared folder of common assessments and scoring guidelines; (4) Create a database for entering scores from common assessments for analysis; (5) Train teachers in the use and scoring of common assessments and ensure interrater reliability; (6) Schedule departmental time to analyze and report on scores from common assessments; (7) Build a cycle of continued review, analysis, reporting, and implementation of subsequent, responsive curricular and instructional actions; (8) Modify the mid-term and final exams across courses. Scheduling of exams will need to be adjusted based upon course vs. period.

Estimated Budget/Resources: If this writing occurs during the school year on non-in-service days, the cost of substitutes and/or ancillary pay could be incurred.

Potential Implications (Short-Term and Long-Term): Within the model for teaching and learning, instruction and curriculum will be better aligned with the assessments as a common benchmark. Teachers will be able to utilize the data gleaned from common assessments to adjust their own instruction to be responsive to learners. Additionally, changes to the curriculum and/or instructional strategies could be explored and documented for the department to utilize when helping students successfully master and employ the concepts and skills intended through the written curriculum.

Recommendation #4

Align Pine-Richland K-12 curriculum to current PA Science Standards, incorporating best practices, while emphasizing content and skills.

- Incorporate a cross-curricular approach to instruction aligned to the PA Core Academic Standards for Reading and Writing in Science and Technical Subjects, which includes reading, writing, listening, and speaking, while using empirical evidence to defend one's position.
- Determine scope and sequence of assured reading and writing experiences and revise the K-12 Science Curriculum accordingly.
- Incorporate text-dependent analysis through reading of expository texts and current journal articles into K-12 science courses.
- Incorporate documentation of scientific writing; consider using the "model" science notebook for reading, writing, analysis, etc., to reinforce a common non-fiction writing format and language (technical writing) using back-mapping of curriculum, in grades 3-12, to ensure expectations are met by grade 12.

FINDINGS:

Internal Analysis

1. K-12 curriculum review process in 2014-2016 was aligned to the PA Standards without intentional consideration of the Next Generation Science Standards (PRSD Expanded Curriculum Review Team, 2017).
2. The need for increased growth in science achievement has been demonstrated by our PVAAS data over the past three years (PRSD Annual Academic Achievement and Growth Report, 2016).
3. The PRSD Expanded Curriculum Review Team has identified the use of science notebooks as a current programmatic strength, teaching students the scientific process, and introducing the basics of technical writing (PRSD Vertical Alignment Team, 2013).
4. There are not consistent resources being utilized across courses to supplement the core instruction with source documents and current research (PRSD Expanded Curriculum Review Team, 2017).

External Analysis

1. In order to guide the future of science instruction and to establish college and career readiness, The Next Generation Science Framework was developed in 2012 and followed in 2013 by the release of Next Generation Science Standards (NGSS, 2013).
2. The PDE has revised its state standards for Science and incorporated NGSS standards. The revised state standards will be released soon (PDE, 2017).
3. Schools are now aligning aspects of their curriculum to the NGSS (Neshaminy School District, 2017).
4. Position statements and philosophies of institution experts recommend increasing students' opportunities for writing to focus on creating arguments and supporting each with evidence (Chatham, 2017; CMU, 2017; Duquesne University, 2017; Phipps Conservancy, 2017; PA Core Reading and Writing in Science and Technical Subjects Standards, 2014; NSTA, 2016).
5. Corporations and universities seek candidates demonstrating strong analytical communication skills (PSU, 2017; Phipps Conservatory, 2017; Mitsubishi, 2017; PPG, 2017; Chatham University, 2017; Duquesne University, 2017; National Weather Service, 2017).
6. Exemplar schools emphasize writing in science with the use of model notebooks and provide professional development to ensure the use of best practices in science education (Unionville-Chadds Ford, 2017; Fox Chapel, 2017).

7. There are natural connections between the non-fiction skills taught through the English Language Arts courses and the application of these skills within the science classes to create relevance (PA Core Reading and Writing in Science and Technical Subjects Standards, 2014).
8. All businesses and universities supported the essential practices outlined in the NGSS (PPG, 2017; Chatham, 2017; National Weather Service, 2017).
9. National Science Teachers Association (NSTA) position statement on NGSS "Engage all students through the use of scientific and engineering practices to strengthen connections to core concepts."
10. Exemplar schools/districts are adopting the NGSS (Neshaminy School District, 2017).
11. All businesses and universities expressed a strong need for problem-solving ability, communication skills, collaboration skills, and critical thinking (PPG, 2017; Chatham, 2017; National Weather Service, 2017).
12. All universities expressed the importance of students to question literature and scientific findings. Students should not accept information as fact without proof (PPG, 2017; Chatham, 2017; National Weather Service, 2017).
13. *A Framework for K-12 Instruction* provides rationale for why engaging in the practices of science and engineering are essential to science instruction (NRC Framework, 2012).
14. The practice of science includes mathematical and computational thinking and has four common elements: problem solving; modeling; analyzing and interpreting data; and statistics and probability" (Sneider, et. al., 2014).
15. PDE states within its Science Curriculum Framework, K-12 Inquiry and Design (Scientific Practices), document, "The nature of science and technology is characterized by applying process knowledge that enables students to become independent learners" (PDE Science Curriculum Framework, 2017, p.1).

Implementation Timeline (Anticipated Start/Finish): 5/1/2017 - 6/1/2018

Key Personnel: Science Department Chair, Science Teachers K-12, Administrative Liaisons to the Department, Assistant Superintendents

Major Action Steps: (1) Identify a core team of grade level representatives to infuse NGSS into the current curriculum as appropriate; (2) Provide training in NGSS to the K-12 teachers; (3) Analyze intersections and opportunities for combination of current curriculum, PA Standards, and NGSS; (4) Revise the curriculum and enter it into the online curriculum folders and sequence; (5) Balance hands-on, active learning experiences with traditional, text-dependent education; (6) Develop skill-based common assessments and associated rubrics K-12; (7) Review changes with teachers for implementation in their daily lessons.

Estimated Budget/Resources: Limited costs are anticipated unless speakers from NGSS are brought in for in-service sessions. Costs associated with curriculum development (ancillary pay, substitutes, etc.) could be incurred.

Potential Implications (Short-Term and Long-Term): Ensuring an intersection among the PA Standards, PRSD Curriculum, and NGSS will enhance the depth and rigor of our curriculum and better prepare our students for college work and careers. Incorporating NGSS into our curriculum will provide common understanding of pedagogy, vocabulary, knowledge and skills and assist teachers in providing a common experience for students in science education K-12.

Recommendation #5

Focus professional development in the area of scientific practices and embed specific learning goals about those practices within the unit-based curriculum (i.e., see bullet 3 below).

- Incorporate reading and writing skill instruction and source document acquisition.
- Integrate journals and periodicals to supplement instruction with appropriately leveled research (e.g., ChemMatters).
- Systematically embed scientific and engineering practices in instructional strategies throughout all K-12 science courses. Practices include:
  - Asking questions and defining problems
  - Developing and using models
  - Planning and carrying out investigations
  - Using mathematics and computational thinking
  - Analyzing and interpreting data
  - Constructing explanations and designing solutions
  - Engaging in argument from evidence
  - Obtaining, evaluating, and communicating information

FINDINGS:

Internal Analysis:

1. A gap exists in providing professional development differentiated for science teachers (Vertical Team, 2015).
2. A gap exists between the presentation of professional development material and implementation in the classroom. This is largely due to lack of "buy-in" on the techniques and a real or perceived lack of time to implement them. The increase in time and a philosophy statement with an overarching goal would allow for more, better-planned professional development opportunities (Vertical Team, 2015).
3. The Pine-Richland Curriculum Strengths/Needs Assessment revealed a need for K-12 teachers to meet with colleagues to discuss content and lessons, in tandem with an increase in science-specific professional development reflective of best practices in science and instructional approaches to teaching the sciences (Vertical Team, 2015).
4. Teachers inconsistently use these skills and practices in their classrooms (Vertical Team, 2015).
5. Our current curriculum is all content based and does not include the development of key skills of scientific practice (Vertical Team, 2015).

External Analysis:

1. Exemplar schools focus on professional development and training specific to content area needs (UCFSD, Neshaminy School District, North Penn, Downingtown STEM Academy, 2017).
2. Exemplar schools provide a strong spirit of collaboration amongst staff (North Penn Senior High School, 2017).
3. Exemplar schools provide positive and collaborative staff environments with discussions occurring both within and across grade levels (Fairview Elementary, 2017).
4. The NSTA Position Statement captures professional development in science education stating, "To be prepared for the 21st Century, it is critical that all students have sufficient knowledge of and skills in science. Studies suggest that high-quality teaching can make a significant difference in student learning. NSTA believes a high-quality science teacher workforce requires meaningful, ongoing professional development. To achieve this goal, schools and school systems must devote time and resources to effective professional development for all K–16 teachers of science and science educators to support

learning throughout their careers" (NSTA, "Professional Development in Science Education", 2016).

5. In terms of incorporating technology into classrooms, a digital divide exists between the passive use of technology for reading and accessing information and the active use of technology involving peer collaboration, design, global connections, interaction with experts, media production, immersive simulations, and coding (Office of Educational Technology, 2016).
6. The three main principles driving the universal design for learning include providing multiple means of: (a) representation so that students can approach information in more than one way; (b) expression so that all students can demonstrate and express what they know; and (c) engagement to stimulate interest in and motivation for learning (Office of Educational Technology, 2016).
7. NSTA supports e-learning for blended instructional approaches for K-16 students that provide opportunities for students to develop and use science and engineering practices, disciplinary core ideas, and crosscutting concepts in order to explain phenomena or design solutions to problems (NSTA, 2016, p. 3).
8. Students should use technology (e.g., spreadsheets) in labs to organize and analyze data (Sneider, et.al. 2014).
9. Provide background training for project-based, problem-based, and inquiry-based learning (NASD, CMU, PPG, and NSTA Position - Teacher Preparation).

Implementation Timeline (Anticipated Start/Finish): 5/1/2017 - Ongoing

Key Personnel: Professional Development Committee, Science Department Chair, and Assistant Superintendents

Major Action Steps: (1) Identify prioritized needs for both general and grade-specific professional development across the K-12 science teachers; (2) Allot departmental and/or grade level in-service time for identified training needs when outlining the professional development calendar; (3) Create professional learning networks among teachers to collaborate regarding instructional approaches and resources, and (4) Demonstrate results based upon changes in teaching and learning resulting from the professional development sessions to advocate for and guide future trainings.

Estimated Budget/Resources: Outside providers or guest speakers might have fees associated with their workshops or presentations. Utilizing a train-the-trainer model would allow us to send a staff member to a conference or professional development session for the cost of one person with the understanding that they will share their learning with their colleagues.

Potential Implications (Short-Term and Long-Term): Connecting the professional development sessions to results and setting expectations for implementation will ensure an instructional benefit for students and teachers alike. Establishing professional learning networks and ingraining collaboration among teachers will assist in the refinement of teaching and learning opportunities and result in the sharing of best practices.

Recommendation #6
Revise Science Pathways to strengthen and expand opportunities for students to be appropriately challenged in courses within each pathway. Six specific sub-recommendations for revising the Science Pathways include:

6a. Review and revise the every other day supplemental instruction course for students who score below proficient on the Biology Keystone Exam. The course will reinforce Biology content by focusing on crosscutting science skills (e.g., analyzing and interpreting data; constructing explanations and designing solutions; developing and using models).

FINDINGS:

Internal Analysis

1. Creating appropriate Science Pathways is complex because of the breadth of Science standards, the varying levels of student readiness, interest, and motivation, and the strong beliefs about best practice within the Science Department. (PRSD Vertical Team, 2017).
2. Current face-to-face supplemental course has not produced the desired gains. Students enrolled in the 2015 - 2016 course did not pass the Keystone exam after completing the course (Keystone Exam Data, 2016).
3. Most students enrolled in an online supplemental instruction program showed improvement. (Keystone Exam Data, 2016).

External Analysis

1. Provide early intervention in the spring for students projected to score in the high basic range. (North Penn Senior High School, 2017).
2. Summer "Boot Camp" remediation class offered to non-proficient, but borderline students, after receiving results. If this option is taken, and successful, the students do not have to take a class in the fall (North Penn Senior High School, 2017).
3. Keystone Remediation Program that provides practice during lunch (similar to "Math Help" at PRHS) where Certified Teachers provide support and remediation practice during lunch, study halls, or before/after school (Neshaminy School District, 2017).

Implementation Timeline (Anticipated Start/Finish): 5/1/2017 - 6/1/2018

Key Personnel: 9-12 Science Teachers, Science Department Chair, Keystone Remediation Administrator, High School Principals, & Asst. Superintendents

Major Action Steps: (1) Review current supplemental instruction model and identify opportunities for improvement; (2) Develop and implement an early intervention experience for students based on score projections; (3) Communicate the need for early intervention courses to applicable students and their parents annually; and (4) Analyze the impact of new supplemental instruction and proactive remediation courses on students' Keystone success rates.

Estimated Budget/Resources: Potential costs are associated with the proactive remediation courses for students, depending on when they are offered, during or outside of the school day. Our current remediation

model includes the following resources: USA Test Prep or every other day direct instruction.

Potential Implications (Short-Term and Long-Term): As a result of these changes, students should be better prepared to demonstrate their mastery levels through the Keystone assessments and be equipped with the necessary knowledge and skills to be successful after graduation. If we are utilizing the Pennsylvania Value Added Assessment System (PVAAS) projected scores, we should be able to remediate students with needs, prior to them taking an assessment and needing to enroll in supplemental instruction because of a non-passing score.

6b - Award science credit for students taking any course within the Pine-Richland High School Science Department pathway options beginning with the 2018-2019 school year. Biology will continue to be a required course for all students.

FINDINGS:

Internal Analysis

1. Other core departments at Pine-Richland High School currently do not distinguish between core / elective courses. (Pine-Richland High School Program of Studies, 2017)
2. Biology is a required course for Pine-Richland students because students must pass the Biology Keystone Exam as part of their graduation requirements (PRSD Board Policy #217, 2014).
3. Data collected over the past three school years shows there are students still needing an additional credit for graduation that do not meet the math requirements for Academic Physics (Pine-Richland internal scheduling data, 2016).

External Analysis

1. All students will be required to demonstrate proficiency on the Algebra 1, Biology, and English Literature Keystone Exams as well as satisfactorily pass all required credits (3 Science credits), in order to graduate from high school and receive a high school diploma. Science classes are Physical Science (9th grade), Biology (10th grade), and any other science course offered at NPSHS to obtain those three required credits (North Penn Senior High School, 2017).
2. Currently, North Allegheny requires three credits of Science to graduate. Every student must take Biology in grade 9 or 10. Then, the required, additional two credits of Science can come from ANY of the available Science courses offered (North Allegheny School District, 2017).

Implementation Timeline (Anticipated Start/Finish): 9/1/2017 - 1/10/2018

Key Personnel: High School Administrators, Science Department Chair, & Assistant Superintendents

Major Action Steps: (1) Alter the program of studies and other relevant course-mapping documentation to support the use of any science class for credit beyond the Biology requirement; (2) Change the current credit loadings in the Naviance and transcript software to align with the recommendation; and (3) Communicate changes to current students and their parents.

Estimated Budget/Resources: No costs are associated with this recommendation. Changes will need to be made to existing documentation, databases, and communications, without incurring fees.

Potential Implications (Short-Term and Long-Term): Students will be able to meet the graduation requirements through the pursuit of Biology and any other two science courses, based upon their interest and potential career pursuit. This will provide more flexibility for all students.

6c - Offer AP Physics C with an option for students to take the CHS Physics Exams and explore adding additional AP courses to the high school program of studies (e.g., AP Environmental or AP Physics 1).

FINDINGS:

Internal Analysis

1. Student outreach revealed that students would like AP Physics to be offered. Students also expressed that they would like more options in the science program of studies. (Student Input, 2017)

External Analysis

1. Exemplar programs offer a greater variety of AP science courses (Northern Penn, 2017; North Allegheny, 2017; Downingtown, 2017).
2. Currently exemplar programs offer multiple AP level Physics Courses. These would serve as a quality supplement to the currently effective CHS Physics. (Northern Penn, 2017; North Allegheny, 2017; Downingtown, Unionville-Chadds Ford, 2017).

Implementation Timeline (Anticipated Start/Finish): 5/1/2-17 - 6/1/2020

Key Personnel: High School Administration, Science Department Chair, & Assistant Superintendents

Major Action Steps: (1) Create AP Physics course and curriculum for inclusion in the PRHS Program of Studies; (2) Communicate to students and parents the addition of the new AP Physics course and option for CHS Physics Exam through the Program of Studies and other relevant communications; and (3) Examine enrollment and AP exam performance data for AP Physics over the first years of implementation and course offering.

Estimated Budget/Resources: Costs related to professional development for staff to teach various AP Physics courses. The current practice of reimbursing students scoring 3+ on the AP exam will continue. Students will be required to take either the AP Physics Exam or the CHS Physics Exam.

Potential Implications (Short-Term and Long-Term): Students leaving PRSD to enroll in a college or university could take with them credits earned while in high school. This could make our students more attractive when going through the application process and would result in cost-savings for families. The addition of a more rigorous course pathway and end-of-course assessment will also provide students craving challenging opportunities with another option. Advance placement courses are nationally normed and recognized by most colleges and universities. This will provide our students with more options to explore as they transition into their postsecondary experiences.

6d - Determine appropriate mathematics requirements for high school science courses and rewrite course descriptions in the Program of Studies to better reflect the differences in the courses and different math expectations for the different levels.

- Remove math prerequisites for Biology courses.
- Revise prerequisite for Honors Chemistry to completion of Algebra 1 and teacher recommendation.
- Revise prerequisite for Academic Chemistry to completion of Algebra 1.

FINDINGS:

Internal Analysis

1. Analysis of three years of Honors Chemistry final grades and Algebra level indicate that students not enrolled in Honors Algebra 2 are successful in Honors Chemistry. (Pine-Richland School District Performance Data, 2017).

External Analysis

1. Exemplar schools do not require students in their Honors Biology and Honors Chemistry courses to be concurrently enrolled in Honors Algebra 2 course (North Penn School District, 2017; Unionville-Chadds Ford School District, 2017; Neshaminy School District, 2017; North Allegheny School District, 2017; Downingtown School District STEM Academy, 2017).

Implementation Timeline (Anticipated Start/Finish): -5/1/2017 - 8/1/2017

Key Personnel: High School Administration, Science Department Chair, and School Counseling Department

Major Action Steps: (1) Alter PRHS Program of Studies to reflect changes in course requirements for the 2018-2019 school year; (2) Update Naviance system and School Counseling Department to reflect changes in course requirements; and (3) Communicate new course requirements to math and science teachers, students, and parents.

Estimated Budget/Resources: No costs will be associated with updating the course requirements.

Potential Implications (Short-Term and Long-Term): Students not taking Algebra 2 have previously been successful in their Honors Biology and Chemistry courses. This alteration to the prerequisites will allow students additional opportunities to pursue higher-level science courses, apart from their math pathway. Teacher recommendations are still required.

6e - Revise science pathway options to include:

- Biology option for all students entering 9th grade possibly with an A/B lab.
    - Open the third tier co-taught Biology course to ninth and tenth graders.
- Remove Honors Earth and the Environment from the High School Program of studies.
- Revise Earth and the Environment Course.
- Examine curriculum for science courses in grades 6 - 12 to address gaps in Earth and environmental science and ensure all students (regardless of pathway) are exposed to content.
- Remove or revise the high school Physical Science course.
- Based on changes to 9 - 10 grade pathways, develop additional courses at the high school (e.g. Meteorology/Ocean Science, Natural Disasters, Ecology, and Geology).

FINDINGS:

Internal Analysis

1. Approximately 85% of students entering the high school take a Biology course (PRSD Pathway Data, 2017).
2. Approximately 80-85% of students taking a 9th grade Biology course are scoring at the proficient or advanced level on the Keystone Exam (Keystone Exam Data, 2014-2016).
3. Approximately only 15% of students are experiencing any Earth science after grade 6 (PRSD Pathway Data, 2017).
4. Honors Earth and the Environment has not been offered over the past 3 years due to low student requests (PRSD Pathway Data, 2015-2017).
5. The curriculum of the high school Physical Science course has a large amount of overlap to the curriculum of the 8th grade science course. (PRSD Curriculum Maps, 2015-2016).
6. With the addition of the third tier Biology and Chemistry courses, 29 students currently (2016-2017) taking a Chemistry course did not meet the math requirements for Academic Physics (2017-2018). These students were recommended for Physical Science. Overlap exists between the high school physical science course and the 8th grade course (PRSD Pathway Data and Teacher Recommendation Data, 2017).

External Analysis

1. Exemplar schools offer a variety of science courses other than Biology, Chemistry, and Physics courses (e.g. Forensic Science, Meteorology) (North Penn School District, 2017; North Allegheny School District, 2017).
2. Exemplar schools do not offer Earth Science as an option for 9th graders. It is offered as the 8th grade science course (Neshaminy School District, 2017; North Allegheny School District, 2017; North Penn School District, 2017; Unionville-Chadds Ford School District, 2017).

Implementation Timeline (Anticipated Start/Finish): 5/1/2017-6/1/2018

Key Personnel: 7-12 Science Teachers, Science Department Chair, High School Administration, and High School Counselors

Major Action Steps: (1) Revise current pathways to ensure Physical Science and Earth Science topics are appropriately addressed and not redundant from middle to high school; (2) Reflect changes in middle and high school course content and sequences within the Program of Studies; and (3) Communicate changes to the sequence to the school counselors, teachers, students, and parents.

Estimated Budget/Resources: The revision and alignment of curriculum across the physical and Earth sciences in both middle and high school courses will require the work of a teacher committee. Costs associated with this depend upon the model implemented to accomplish the work. Changes to the Program of Studies and communications will not incur costs.

Potential Implications (Short-Term and Long-Term): Articulating and aligning the content of our course sequence will ensure the elimination of redundant courses, as skills will be appropriately spiraled throughout the courses and not blatantly repeated. Students will be better focused on high school courses offering additional exposure to sub-disciplines within the sciences, as opposed to repeating content instructed at the middle level. Based upon data reviewed, few students take the Earth Space course at the high school. Integrating Earth/Space concepts throughout the 6-12 science curriculum will ensure all students are provided with opportunities to learn the content.

6f - Create an additional pathway in 8th grade science by establishing a compacted/extended and current course option.

FINDINGS:

Internal Analysis

1. Math, English, and Social Studies all have differing pathways in eighth grade (PRSD Pathway, 2017).
2. Narrowing the range of learners was identified as an opportunity during the curriculum review process (PRSD Strengths and Needs, 2014).
3. The current 8th grade science classes contain a wide range of readiness levels (PSSA and PVAAS Data, 2016).
4. A reduction within the range of student readiness will help teachers better meet the needs of all learners (PRSD Strengths and Needs, 2014).

External Analysis

1. Exemplar schools offer different levels of challenge in their science classes (Unionville - Chadds Ford School District, 2017).
2. Parent feedback strongly and consistently identifies the need for greater challenge in science classes (Community Feedback, 2017).
3. Different Pathways are offered in 8th grade middle school science to serve learners at different levels of readiness (Unionville-Chadds Ford School District, 2017).

Implementation Timeline (Anticipated Start/Finish): Implement beginning in the 2018-2019 School Year

Key Personnel: Middle Level Administrators, Middle Level Science Teachers, Science Department Chair, Middle Level School Counselors, and Assistant Superintendents

Major Action Steps: (1) Create compacted/extended course pathways for 8th grade science; (2) Determine qualification/placement criteria for 7th graders enrolling in 8th grade; (3) Reflect changes to course offerings within the Program of Studies, internal curriculum guides, and published online curriculum descriptions; and (4) Communicate changes to the science teachers, counselors, students, and parents.

Estimated Budget/Resources: There should be limited costs associated with implementing these courses on our own, utilizing existing staff members. The development and identification of extended learning activities could have potential costs.

Potential Implications (Short-Term and Long-Term): Students would receive enrichment opportunities regularly, based upon their demonstration of skills. All students would receive instruction in the same curriculum with pacing to match their unique needs.

Recommendation #7

Facilitate and sustain partnerships with community connections to provide meaningful, consistent experiences across a variety of science fields.

- Coordinate field experiences and guest speakers based upon grade level standards and developmental needs of students, bringing content to life and capturing the opportunities within a shared document.
- Promote apprenticeships available to students within various fields for career exploration (e.g., AIU offerings; National Weather Service).
- Collaborate with PTOs and interested sponsors to offer afterschool programs related to the sciences, bolstering available opportunities for students to engage in science.

FINDINGS:

Internal Analysis:

1. Individual teachers have taken the initiative to identify classroom-specific speakers and standalone experiences, which could be better coordinated among the K-12 span (PRSD Expanded Curriculum Review Team, 2017).
2. Parents indicated an interest in offering STEM courses both inside and outside of the school day (PRSD Parent & Community Input from Town Hall Meeting, 2017).

External Analysis:

1. Fewer and stronger partnerships with local institutions enhance the science curriculum and ensure sustainable experiences (e.g., Chatham University's Eden Hall Campus) (Unionville Chadds Ford School District, 2017; Peters Township School District, 2017; Chatham University, 2017; NSTA Position Statement, 2016).
2. Exploration of the use of electronic visits, virtual reality, and immersive simulations to promote community connections in science education is supported by NSTA (NSTA Position Statement, 2016).
3. Utilizing the environment around the schools allows students to experience science in the field (Phipps Conservatory, 2017; Chatham University, 2017; NSTA Position Statement, 2016).
4. Community connections have voiced an interest in admitting students and teachers for apprenticeship or workshop learning experiences (National Weather Service, 2017; PPG, 2017; Pennsylvania State University, 2017; Phipps Conservatory, 2017).

Implementation Timeline (Anticipated Start/Finish): 5/1/2017 - 6/1/2018

Key Personnel: K-12 Science Teachers, Building Administrators, Office of Communications, and Assistant Superintendents

Major Action Steps: (1) Identify curricular areas to be enhanced by guest speakers, partnerships, and connections to science in action; (2) Examine the current partnerships and resources utilized to bring content to life and determine if additional connections with these same partners can be made; (3) Explore new partnerships with organizations offering beneficial connections and learning opportunities for our students and establish these opportunities as assured experiences across grade levels and/or courses; and (4) Communicate and promote a desire to establish partnership opportunities within the community through both seeking and reporting on these types of experiences in our classrooms.

Estimated Budget/Resources: Parent Teacher Organizations (PTOs) may be willing to support some of the funding needs. Additionally, some partners and organizations might prefer to donate their resources and time to the schools. Costs could be associated with field trips or guest speakers.

Potential Implications (Short-Term and Long-Term): Students would gain an appreciation for and understanding of the importance of science beyond the walls of the classroom. These experiences might encourage them to pursue a career in the sciences and will minimally broaden their knowledge about the application of learning in real world scenarios.

Recommendation #8
Continue the use of Amplify Science in grade 7 and consider extending Amplify Science opportunities into other grades.

7th Grade Life Science Units

- Microbiome (Launch Unit)
- Metabolism (Core Unit - Q1)
- Trait's & Reproduction (Core Unit - Q2)
- Natural Selection (Core Unit - Q3)
- Matter & Energy in Ecosystems (Core Unit - Q4)

FINDINGS:

Internal Analysis

1. The 2014-2016 K-12 curriculum review process assisted in aligning the PRSD curriculum to the PA Standards without intentional consideration for the Next Generation Science Standards at that time (PRSD Curriculum Review Process, 2014).
2. New science texts for the middle school were purchased for the 2016-2017 school year (PRSD Curriculum Review Team, 2016).
3. Amplify Science was chosen for a pilot experience because it is aligned with Next Generation Science Standards and uses an inquiry-based approach (PRSD Curriculum Review Team, 2016).
4. Technology upgrades within the PRMS infrastructure over the summer of 2016, the accessibility of a classroom set of Chromebooks, and the introduction of Google Suites for Education allowed for a pilot of Amplify Science in Grade 7 (PRSD Curriculum Review Team, 2016).
5. Four units of Amplify Science were recommended for implementation during the 2016-2017 school year by all three 7th grade science teachers. In addition, the Microbiome Launch Unit was provided free of charge. The units included: (Launch) Microbiomes; (a) Metabolism; (b) Metabolism Engineering Internship; (c) Natural Selection; and (d) Matter & Energy in Ecosystems (PRSD Amplify Pilot, 2017).

External Analysis

1. Exemplary science education can offer a rich context for developing many 21st-century skills, such as critical thinking, problem solving, and information literacy especially when instruction addresses the nature of science and promotes use of science practices (NSTA, 2016, p. 1).
2. The Next Generation Science Framework was developed in 2012, followed by the release of the NGSS in 2013, to guide the future of science instruction to establish college and career readiness (NGSS, 2013).
3. Position statements and philosophies of institution experts recommend increasing students' opportunities for writing to focus on creating arguments and supporting each with evidence (Chatham, 2017; Carnegie Mellon University, 2017; Duquesne University, 2017; Phipps Conservancy, 2017; PA Core Reading and Writing in Science and Technical Subjects Standards, 2014; NSTA, 2016).

Implementation Timeline (Anticipated Start/Finish): 7th Grade will continue to utilize Amplify Science in 2017-2018 school year. Grades 6 and 8 will introduce Amplify Science through 1-2 units.

Key Personnel: Grades 6-8 Science Teachers, Middle School Administration, Science Department Chair, and Assistant Superintendents

Major Action Steps: (1) Revise the current curriculum to infuse Next Generation Science Standards; (2) Review implementation of units from Amplify Science; 3) Review implementation of units from the current science textbook; 4) Determine units that would benefit from using Amplify Science materials; 4) Budget for purchasing the additional Amplify Science materials; 6) Revise curriculum maps as needed to include Amplify Science materials; 5) Provide professional development to teachers using the Amplify Science materials.

Estimated Budget/Resources: Release time for teachers to meet and accomplish the action steps will equate to the cost of a substitute or ancillary pay. There could potentially be costs for resources if the Amplify Science materials are expanded into other grade levels. Time will need to be allotted for professional development related to the use of Amplify Science materials for applicable teachers.

Potential Implications (Short-Term and Long-Term): Because the Amplify Science curricular materials are aligned to Next General Science Standards and are implemented through an inquiry-based approach to instruction, the use of Amplify Science would advance many of the recommendations developed in this in-depth program review. The experience gained by teachers in seventh grade would assist colleagues in their department in the review of the materials and consideration of their extended use.

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Unionville-Chadds Ford School District. January 18,2017. Nolen, John. Director of Curriculum and Instruction. Hoffman, Tim. Middle School Principal.

Data and Information Subcommittee

Pine-Richland School District. November 21, 2016. "PRSD Academic Achievement & Growth Report."

"Science Curriculum Review Town Hall Meeting." Feb. 2017.

"Science Responses for K-3 Teachers: Top 5 Big Ideas from Reflections." *Pine-Richland Curriculum Strengths/Needs Reflections*, 13 Oct. 2014.

Connections Subcommittee

Mitsubishi. January 25, 2017. Barron, Joe. Director of Corporate Development

National Weather Service. January 19, 2017. Coblentz, Bob. Data Acquisition Program Manager

Phipps Conservancy. January 25, 2017. Shannon, Heather. School and Camp Program Manager

PPG. January 25, 2017. Kauffman, Kristi. Innovation Assoc., Corporate Science & Technology

Carnegie Mellon University. January 25, 2017. Braun, Maggie. Associate Dean of Undergraduate Affairs. Alba,

William. Head of Transition, Recruitment, and Diversity.

Chatham University, Falk School. February 14, 2017 Walker, Peter. Dean Falk School of Sustainability and Environment.

Duquesne University. January 25. 2017. Astle, Janet. Dean for Student Services, Mylan School of Pharmacy.

Pennsylvania State University. January 25, 2017. Williams, Mary Beth Williams. Senior Associate Dean of Undergraduate Studies; Professor of Chemistry, Eberly College of Science.