ADOPTION OF SCIENCE CURRICULUM - PHASE I

POLICY ISSUE/SITUATION:

At the April 16, 2018 School Board meeting the Superintendent was charged with forming a Science Project Team to conduct a curriculum review and make recommendations to the Board in accordance with the District's Quality Curriculum Cycle. The Project Team Report (Phase I) is being presented to the Board and, as a part of that work, the recommendations for a Science Position Statement, Best Practices in Science, Science Learning Targets for Grades 9-12, Instructional Resources for Physics, Chemistry and Biology and a Professional Development Plan for Grades 9-12 are being presented for Board review.

BACKGROUND INFORMATION:

The Science Project Team has completed work on the Position Paper, Best Practices in Science, Learning Targets (9-12) and Science Professional Development Plan (9-12). In addition, instructional resources for Physics, Chemistry and Biology have been recommended. The Learning Targets, which are based on the Next Generation Science Standards (NGSS), provide the core of the curriculum. Instructional resources are tools to help teachers as they move students towards those targets. The Learning Targets, Position Paper, and Best Practices provide the foundation for the selection criteria used in resources evaluation and selection. The Science Project Team Report (Phase I) includes all of these documents and recommendations, and the report is presented to the Board for a first reading.

RECOMMENDATION:
It is recommended that the School Board receive for consideration the Phase I Science Project Team Report.

Science Project Team Report

Phase 1

2019

BEAVERTON SCHOOL DISTRICT

Science Project Team
Phase I Report 2019
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April, 2019

In April of 2018, the Beaverton School District Board charged the Science Project Team with the task of evaluating and making specific programmatic recommendations for the District. The Science curriculum review, as outlined in Board policy and administrative regulation for the Quality Curriculum Cycle, was to include learning targets, instructional practices, assessment, instructional resources and staff development.

Within the review process, the Science Project Team studied science education in the context of today's world. The focus on and demand for higher levels of Science education is evident in the Next Generation Science Standards (NGSS) as well as within the skill set deemed essential for college and career readiness and success. Our goal is to prepare students to engage in the world as critical thinkers and culturally competent citizens; this requires that all students receive a strong Science education

The work of this Project Team has placed an intentional focus on best practices in Science instruction as well as professional development for educators. In addition to the review of student data, the Cadre and Project Team engaged in deep discussion about the essential practices in every classroom as well as the necessary professional learning needed to support these practices.

As a result, the Science Project Team defined a comprehensive set of Phase I recommendations that includes:

- Science Instruction Position Paper
- Best Practices in Science
- Physics / Chemistry / Biology Learning Targets
- High School Professional Development Plan
- Instructional Resources Recommendation

These recommendations point the District towards high quality instructional practices that engage and challenge students in 21st century Science learning.

Phase II work of the Science Project Team will include K-8 Learning Targets, K-8 Instructional Resources, K-8 Professional Development plan, as well as Assessment and Implementation plans.

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WE EXPECT EXCELLENCE WE INNOVATE WE EMBRACE EQUITY WE COLLABORATE

District Goal
WE empower all students to achieve post-high school success.

Science Project Team Members 2018-2019			
Building Level Admin	**MHS / SRHS Region**	**AHS / BHS Region**	**SHS / WHS Region**
Elementary (2)		Cary Meier - Ridgewood	Jennifer Whitten - Findley
			Aki Mori - McKinley
Middle School (1)		Zan Hess - Conestoga	
High School (1)	Doug Boyer - Southridge		
Teachers	**MHS / SRHS Region**	**AHS / BHS Region**	**SHS / WHS Region**
Elementary (4)		Teresa Goetter - Barnes (3rd) (DL)	
	Michelle Brock - Sexton Mt.		
		Carolina Cavedon - Vose (DL)	Bonnie Adams - McKinley (PYP)
Middle School (2)	Karen Black - HPMS	Kristine Rice - Five Oaks	
High School (2)	Charlotte Denis- Mountainside		Tamsen Proffit - SHS
Options		Carlie Harris - HS2	
Specialists (6)			
SpEd	Kyla Zaworski - ALC (MVMS)		
	Susan Bomber - SRC (WMS)		
Mentor	Elise Cohen		
TOSA	Beate Pryor - Chehalem		
STEAM	Carol Biskupic-Knight - Sato		
Parents (4)	**MHS / SRHS Region**	**AHS / BHS Region**	**SHS / WHS Region**
Elementary			Jon Schaeffer - Terra Linda
	Jessica Martin - Nancy Ryles		
Middle School		Cheryl Williams - Mt View	
High School		Molly Malone - BHS, West TV	
Community (2)			
	Neereaj Havaligi		
	Elaine Charpentier Phillipi - BEC Exec. Dir.		
Students (3)	**MHS / SRHS Region**	**AHS / BHS Region**	**SHS / WHS Region**
High School			Maria Kolattukudy - WHS
			Mayukha Kashyap - SHS
Options	Jasmine Guliani - SST		
District			
TOSA	Susan Holveck (Resigned)	Secondary CIA Admin	Brian Sica
TOSA	Caitlin Everett	Elem CIA Admin	Jared Cordon
TOSA	Jenny Read Emslie	Support	Susan Ouellette
TOSA	Dawn Guildner	School Board	Tom Colett
TOSA	Katie White		
TOSA	Jen Burkart		

Science Position Paper K-12

A strong science education is essential for creating scientifically literate learners who are empowered to improve their lives, communities, and the world.

Students must develop critical thinking skills to observe, question, and explain the world around them. Students achieve this through active engagement in the following practices of science and engineering as outlined in the Next Generation Science Standards (NGSS):

- Asking questions and defining problems
- Developing and using models
- Planning and carrying out investigations
- Analyzing and interpreting data
- Using mathematics and computational thinking
- Constructing explanations and designing solutions
- Engaging in argument from evidence
- Obtaining, evaluating, and communicating information

Through engagement in these practices, students will build a deep understanding of the core ideas of science as well as the ability to apply concepts across disciplines, developing an intuitive sense of how the world works. Students will be critical thinkers who develop solution-focused ideas and evidence-based perspectives, preparing them to solve personal, community and global challenges.

For students to achieve these goals, teachers will provide varied opportunities for students to engage in rigorous, accessible, and challenging curriculum and provide student-centered instruction. Inquiry and engineering tasks should leverage the diverse backgrounds, experiences, and abilities of each student in a collaborative environment. Curriculum, instruction, and assessment must be differentiated to meet the needs of each learner, be relevant to the lives of students, utilize appropriate technology, and have a real-world context. Through these experiences, students will learn to challenge their assumptions, critically consume information, and act independently.

Science instruction that will make student experiences a reality starts with high-quality instructional materials and resources from kindergarten through 12th grade. Along with materials, educators need relevant, effective, evidence-based, and ongoing professional development. With opportunities for professional learning and collaboration, teachers will increase student achievement by developing and providing safe and effective learning environments, science experiences, and ongoing assessments that inform instruction and include opportunities for student reflection on progress toward learning targets.

Ultimately, a science education is achieved through a partnership among all stakeholders: teachers, administrators, students, families, schools, and our diverse communities. The responsibility of the Beaverton School District is to create and sustain rich and inclusive learning experiences, in which these stakeholders work together to ensure all students are valued for their diversity; fostered in their scientific thinking; empowered to explore, collaborate, and solve problems; and challenged to continue learning throughout their lives.

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Best Practices in Science

The Science Best Practices document summarizes research-based strategies for science instruction in alignment with the 5 Dimensions (5D™)* of Teaching and Learning. This document was constructed and reviewed based on instructional practices from research and various professional resources by science content specialists as well as expert teachers, representing the entire K-12 grade range. It is our belief that through the implementation of these practices, we can achieve our mission and vision for K-12 science education in Beaverton.

*"The 5D™ instructional framework provides a common language of instruction that defines teaching and learning along five dimensions: purpose, student engagement, curriculum and pedagogy, assessment for student learning, and classroom environment and culture."

PURPOSE: "The purpose of science education is to develop students into scientists, not just people who know about science." This is accomplished by integrating disciplinary core ideas, science and engineering practices, and cross-cutting concepts while challenging students to use critical thinking and science practices as tools to understand science content.

Standards: Context-rich performance expectations as laid out by the NGSS across the three dimensions; Disciplinary Core Ideas, Cross Cutting Concepts, and Scientific Practices.

- **Units of study:** Each unit of study integrates the standards across disciplinary core ideas, science and engineering practices, and cross-cutting concepts.
- **Tasks:** The task is meaningful and relevant to students; place-based phenomena is used.

Learning Targets and Teaching Points: Content knowledge or skills to be obtained that group together common themes across multiple standards

- **Assessment:** Student tasks develop student conceptual knowledge and science practices for learning (formative assessment) or assess learning of student conceptual knowledge and science practices (summative assessment).
- **Learning Targets:** Beaverton's Academic Learning Targets (ALTs) and supporting targets (ASTs) are inclusive of all three dimensions of the NGSS (science and engineering practices, disciplinary core ideas, and crosscutting concepts)
- **Application:** Learning targets facilitate and assess a student's ability to communicate what they have learned and can describe how it is meaningful/applicable in their life.
- **Student Ownership:** Students can demonstrate understanding of learning targets which are written with student-facing language.
- **Student Self-Assessment:** The criteria for success are clear to students and the performance tasks provide evidence that students are able to understand and apply learning in context.
- **Differentiation:** Learning targets allow for flexible differentiation to meet the needs of individual students.
- **Revision and Improvement:** Lessons provide students opportunities to clarify their own work, ask questions and make decisions on their own practices especially with regard to perceived failures and misconceptions resulting in revisions or a follow up investigation.

STUDENT ENGAGEMENT: Engagement is strongest when it builds on student's curiosity about the world around them and they are encouraged to think, wonder, and participate in the science practices. Engagement is evident when students are working collaboratively to create their own explanations, models and solutions to real world phenomena and problems.

Intellectual Work: Students' classroom work embodies substantive intellectual engagement. Students take ownership of their learning to develop, test and refine their thinking.

- **Cultural Context:** Implementing culturally responsive instruction; Build on students' cultural and linguistic strengths. Integration of students' cultural assets into instruction increases active engagement and thus empower students in their own learning.

Engagement Strategies: Engagement strategies capitalize on and build upon students' academic background, life experiences, culture and language to support rigorous and culturally relevant learning. Engagement strategies encourage equitable and purposeful student participation and ensure that all students have access to, and are expected to participate in, learning.

- **Student-centered Scientific Engagement:** Students are using scientific practices such as inquiry, building explanations for phenomena, engineering design to solve problems, etc. Students are actively developing, testing and refining their thinking. (workshop model)
- **Engagement First:** It comes before and inspires the content; building on curiosity, hands-on experiences and student personal and cultural knowledge is the foundation for inquiry and model development.

Talk: Student talk reflects discipline-specific habits of thinking and ways of communicating. Student talk embodies substantive and intellectual thinking.

- **TALK:** Talk is student centered, i.e. 80% student talk to 20% teacher talk, with academic language support and intentional planning for rigorous academic discourse.
- **Discipline Specific Communication:** Students become adept at expressing themselves using scientific thinking and language.

CURRICULUM AND PEDAGOGY: Students are engaged through meaningful phenomena and shared experiences that reflect the collaborative practice of science and engineering as experienced in the real world. The curriculum provides opportunities for teachers to tailor the instruction with respect to individual needs and background knowledge of their students.

Curriculum: Curriculum and instruction engages all students in authentic and meaningful scenarios that reflect the practice of science and engineering as experienced in the real world and provide students with a purpose.

- **Phenomena Based Materials:** Instructional materials should be based on topic specific phenomena. Materials cultivate students to construct explanations or design solutions to problems through student driven inquiry.
- **Collecting and Analyzing Data:** Instructional materials should engage students in questioning, collecting and analyzing data, designing investigations, and creating explanations based on evidence.
- **Engineering Design:** Instructional materials reflect the need for students to acquire engineering design practices and concepts alongside the practices and concepts of science.
- **Promoting Scientific Communication:** Materials should support discourse and the types of conversations that students need to support their sense-making and engagement in science.

Teaching Approaches & Strategies: Teaching approaches provide multiple and diverse opportunities that are student-centered to engage students in phenomena sensemaking, creation of scientific models, and authentic products.

- **Student-Centered Collaboration and Critical Thinking:** The teacher acts as a facilitator while providing multiple opportunities for developing higher order cognitive skills and collaboration.

- **Phenomena Sensemaking:** Teacher creates learning experiences to uncover student thinking, elicit students' ideas, and bring to the surface misconceptions around a science phenomena through the use of probing questions.
- **Developing and Using Models:** Instruction supports students creating and defending models to explain phenomena and real world events.
- **Multiple and Diverse Learning Opportunities:** Teacher provides a variety of opportunities to access curriculum and expand entry points, while utilizing creativity in product form, and addresses the English Language Proficiencies.
- **Authentic Student Products and/or Actions:** Teacher employs instructional practices (project based, with students contributing to scientific understanding) emphasizing current scientific issues and student identity, strengths and interests, throughout the lessons and as part of culminating project.
- **NGSS 3-Dimensions:** The three dimensions of Disciplinary Core Ideas (DCIs), Science and Engineering Practices (SEPs), and Crosscutting Concepts (CCCs), should not be presented as separate entities but must be integrated together in instruction.

Scaffolds for Learning: Teachers need to understand their students' strengths, challenges, culture, and background knowledge in order to tailor instruction with respect to the individual needs of students.

- **Formative Assessment:** Teacher conducts ongoing formative assessments so that they have a working knowledge of where students current understanding is. Multiple opportunities in a variety of styles should be given to students to allow for mastery of learning targets.
- **Language Acquisition:** Students have access to multilingual resources that are culturally relevant, can access the curriculum at their reading level, are provided audio curriculum when necessary, and the material is read out loud when appropriate. Comprehensible input is used so students have an understanding of vocabulary and language.
- **Background Knowledge:** Teacher builds on background knowledge through relevant activities, and content is related to ALL student experiences. Vocabulary is scaffolded through a common phenomena that students have experienced in order to build language proficiency and provide an anchor for their learning.
- **Student Tools:** Graphic Organizers and visual aids are used to help students make meaning of content. Scaffolds are used to allow all learners to access grade level curriculum as they build language proficiency.
- **Instruction:** Teacher models expectation and academic language through sentence frames, student examples, and constructing meaning cards. Differentiated instruction is a blend of whole class, group, and individual instruction and provides multiple approaches to content, process, and product.

Assessment for Student Learning: The use of varied, frequent formative/self/summative assessments in science facilitates diagnostic teaching and learning of the three dimensions of the NGSS performance expectations.

Self-Assessment: Students assess their own learning in relation to the learning target

- Students self-assess and self-reflect after assessment opportunities
- Formative assessment will continue learning by providing qualitative feedback (talk prompts & questioning to elicit student thinking) and enabling students to take responsibility for their learning (self & peer assessment).
- Pre & post assessments, as well as learning trajectory, are culturally responsive, valuing students'

experiences and background (increasing student accessibility and providing a space for student's voice.)

Expectation that all students demonstrate learning through varied forms and multiple assessment opportunities.

- Learners must be evaluated using multiple and varied forms of formative, summative, and diagnostic assessments, allowing for multiple opportunities to show learning.
- Assessments provide opportunities to communicate understanding without constraints of language development.
- Assessments provide various opportunities for argumentation using evidence to support claims, evaluation of discussion, explanation of phenomena, and reflection.

Assessment is standards-based and aligned to the NGSS focus on Disciplinary Core Ideas, Science and Engineering Practices, and Cross-Cutting Concepts.

- Assessments use task specific rubrics that make the criteria for success clear to students, facilitating student self-assessment.
- Assessments focus on making sense of phenomena, and provide opportunities for making claims and supporting claims with evidence and scientific argumentation.
- Assessments are multi-component tasks (i.e. there are multiple questions that students can answer that pertain to a single scenario, assessing more than just what students know, but also student's grasp of practices)

FORMATIVE ASSESSMENT & ADJUSTMENT

- Embed formative assessment throughout instruction to reflect on learning, provide real time feedback on standards based learning targets, and to adjust instruction.
- Teacher uses system to record student assessment data.
- Understand students' "learning trajectories" before assessing, to more effectively identify where & why misconceptions are likely to arise. (imagine a range of student responses to the assessment)
- Formative assessment will continue learning by providing qualitative feedback (talk prompts & questioning to elicit student thinking) and enabling students to take responsibility for their learning (self & peer assessment).
- Use data driven decision making to identify areas for improvement. (Data can be observations, student performance, etc.)

CLASSROOM ENVIRONMENT AND CULTURE: Students participate in phenomena based inquiry and design through productive classroom discussions, opportunities, and structures to safely share their learning and discovery. All students, without exception, are acknowledged, appreciated, valued, and respected. Teachers foster a supportive, inclusive, challenging, and caring classroom community. The classroom space provides flexible opportunities for learning and collaboration, empowering students to be independent learners.

Use of Physical Environment:

- Set up and design a classroom that allows for individual work time, partner work and small or large groups.
- Promote an inquiry-based learning environment that utilizes manipulatives, visual, and graphic support (scaffolds).
- Ensure resources, supplies, and technology are readily available for teachers and students.

Classroom Routines and Rituals:

- Encourage student talk to increase classroom sensemaking that results in deeper understanding.
- Provide students with time to reflect on their thinking before sharing.
- Provide classroom routines and rituals that account for different learning styles, cultural backgrounds, and language proficiency.

Classroom Culture:

- Foster a culture that values students' life experiences as community assets.
- Focus on student reasoning in class discussions rather than looking for the "right" answer.
- Foster an environment that supports student engagement in scientific inquiry and engineering design while encouraging students to reach for new levels of expertise.

Physics Learning Targets 2019

ALT 1: Patterns

Finds patterns in nature and use them to predict future results or understand past events.

> **AST 1.1** - Conducts an investigation to find and communicate the relationship between an independent and dependent variable, a relevant mathematical pattern in the collected data, and a correct prediction an additional data point.
>
> **AST 1.2** - Represents the patterns: linear, quadratic, horizontal, and inverse graphically, mathematically, in data tables, and in words.
>
> **AST 1.3** - Makes a high school level graph (labeled axis, scale, data points with error bars, applicable best-fit), explain its meaning (pattern and slope), and use the graph to make an accurate prediction.
>
> **AST 1.4** - Identifies, compares, and contrasts patterns, specifically including the concept of rate of change (slope).
>
> **AST 1.5** - Communicates the value of finding patterns and explains the reasoning behind making data-informed decisions based on them.

ALT 2: Energy

Models patterns in energy conservation and transformation to explain and predict interactions within systems.

> **AST 2.1 - Inquiry:** Collects data and uses it to demonstrate relationships between forms of energy (kinetic, elastic, or gravitational).
>
> **AST 2.2** - **Engineering:** Creates a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.
>
> **AST 2.3 - Informational Text:** Reads and uses informational texts about energy and its impacts on society to answer relevant questions.
>
> **AST 2.4 - Qualitative Descriptions of Energy**: Uses conservation of energy to qualitatively and conceptually describe energy transfers and transformations in a variety of systems graphically, diagrammatically (energy bar graphs), and with words.
>
> **AST 2.5 - Quantitative Predictions of Energy:** Identifies, expresses, and uses patterns in energy conservation to mathematically predict amounts of energy and related quantities (e.g. height, velocity, mass, stretch/compression, etc.).

ALT 3: Forces, Motion & Momentum

Models patterns in forces to explain and make predictions about the momentum of objects and forces they experience.

> **AST 3.1 - Inquiry:** Analyzes data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.
>
> **AST 3.2** - **Engineering:** Applies scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.
>
> **AST 3.3 - Informational Text:** Reads and uses information texts on forces and motion and its impacts on society to answer relevant questions.
>
> **AST 3.4 - Qualitative Descriptions of Forces, Motion, and Momentum**: Effectively communicates about everyday situations in terms of the patterns in forces and impulse.
>
> **AST 3.5 - Quantitative Descriptions of Forces, Motion, and Momentum:** Identifies, expresses, and uses patterns in forces, motion, and momentum to mathematically predict amounts of force, motion, and momentum and related quantities.
>
> **(Including NGSS :**Uses mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.

ALT 4: Waves: Employs patterns in wave properties to explore technological applications and explain observed phenomena.

AST 4.1 - **Inquiry:** Collects data and uses it to demonstrate relationships between wave properties.(HS-PS4-1) Uses mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media. (Partially addressed in AST 4.1 & AST 4.5)

AST 4.2 - **Engineering:** Applies scientific and engineering ideas to design, evaluate, and refine a device or protocol that utilizes waves to manipulate information and energy.

AST 4.3 - **Informational Text:** Reads and uses informational texts about waves and their impact on society to answer relevant questions. HS-PS4-4. Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.

AST 4.4 - Qualitative Descriptions of Waves and Wave Technology - Effectively communicates about everyday situations, specifically wave technology and digital information, in terms of the patterns in waves (e.g. medical imaging and sonar).

AST 4.5 - **Quantitative Description of Waves:** Identifies, expresses, and uses patterns in waves to mathematically predict related quantities of waves.

HS-PS4-1. Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.(Partially addressed in AST 4.1 & AST 4.5)

HS-PS4-5. Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.

HS-PS4-2. Evaluate questions about the advantages of using a digital transmission and storage of information.

ALT 5: Electromagnetism and Power

Analyzes systems of varying scale in electric power production and energy distribution

AST 5.1 - **Inquiry:** Conducts an investigation to build an argument for the interrelatedness of electromagnets and generators.

HS-PS2-5. Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.

HS-PS3-5. Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.

AST 5.2 - **Engineering:** Designs, builds, and refines a device that works within given constraints to convert one form of energy into another form of energy.

AST 5.3 - **Informational Texts:** Reads and uses information texts about electricity and magnetism to answer relevant questions.

HS-PS4-3. Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.

AST 5.4 - **Qualitative Description of Electricity and Power Production:** Qualitatively describes how electricity generation and distribution impacts society.

HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

HS-ESS3-2. Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios

AST 5.5 - **Quantitative Description of Electricity and Power Production:** Identifies, expresses, and uses patterns in electricity and power production to mathematically predict related quantities.

AST 5.6 - **Energy Flow and Climate Change**: Uses a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate

ALT 6: Space and the Universe

Uses mathematical representations and astronomical evidence to explain the Big Bang Theory and the motion of objects in space.

AST 6.1 - **Inquiry:** Conducts an investigation to build an argument for the interrelatedness of HS-ESS1-4. Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.

AST 6.3 - **Informational Texts:** Reads and uses information texts about space and the universe to answer relevant questions.

AST 6.4 - **Big Bang Theory:** HS-ESS1-2. Constructs an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe.

AST 6.5 - **Gravitation and Coulomb's Law:**
HS-PS2-4. Uses mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.

ALT 7: Inquiry and Investigation

Uses and communicates a variety of scientific practices to make predictions about how the world changes.

AST 7.1 - Formulates the question - Based on observations and science principles, formulates a question or hypothesis that can be investigated through the collection and analysis of relevant information.

AST 7.2 - Designs the Investigation - Designs and conducts a controlled experiment, field study, or other investigation to make systematic observations about the natural world, including the collection of sufficient and appropriate data.

AST 7.3 - Collects and Presents Data - Collects, organizes, and displays sufficient and appropriate data to facilitate scientific analysis and interpretation.

AST 7.4 - Analyzes and Interprets Results - Summarizes and analyzes data to draw a valid and supported conclusion to communicate the findings of an investigation, and identify uncertainties.

AST 7.5 - History of Science - Identifies examples from the history of science that illustrate modification of scientific knowledge in light of challenges to prevailing explanations.

AST 7.6 - Knowledge and Technology Progression - Explains how technological problems and advances create a demand for new scientific knowledge and how new knowledge enables the creation of new technologies.

ALT 8: Engineering:

Explains and applies the engineering process as an iterative and productive means of problem solving.

AST 8.1 - Identify and Define the Problem - Describes a problem to be solved through the process of engineering, describe the relevant principles that relate to the problem, and identify appropriate criteria and constraints for a solution.
HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

AST 8.2 - Generate Possible Solutions - Evaluates and selects an engineering solution from a range of possible options and defend that solution for testing using trade-offs, criteria, and constraints

AST 8.3 - Test Solution(s) and Collect Data - Test solution(s) by collecting, organizing, and displaying data to facilitate the analysis and interpretation of results.

AST 8.4 - Evaluate Solutions -Evaluates a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts

AST 8.5 - Impacts of Technology - Describes how new technologies enable new lines of scientific inquiry and are largely responsible for changes in how people live and work.

AST 8.6 - **Engineering Process** - Designs a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. (HS-ETS1-2)

Chemistry Learning Targets 2019

ALT1 - KMT and Climate Change - Use models to illustrate how pressure, temperature, and volume affect the motions of particles and how this relates to climate change.

AST 1.1: Conducts an investigation to develop a model that illustrates that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative positions of particles (objects).

AST 1.2: Use principles of kinetic molecular theory to engineer a device that solves a real world problem.

AST 1.3: I can read and analyze information texts about climate change and kinetic molecular theory to answer relevant questions.

AST 1.4: Analyze geoscience data and the results from global climate models to make an evidence-based forecast on the current of global or regional climate change and associated future impacts to Earth systems

AST 1.5: Use a computational representation to illustrate the relationships among earth systems and how those relationships are being modified due to human activity

ALT2 - Atomic Structure and Periodic Table - Use models of the atom to describe how valence electrons determine the patterns of the periodic table and the properties of the elements.

AST 2.1: Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.

AST 2.2: Engineering - Use principles of atomic theory or periodic trends to engineer a device that solves a real world problem

ALT 2.3: I can read and analyze informational texts about atomic structure and the periodic table to answer relevant questions.

ALT3 - Nuclear Processes - Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.

AST 3.1: Conducts an investigation to develop a model that illustrates the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.

AST 3.3: I can read and analyze information texts about nuclear chemistry to answer relevant questions.

AST 3.4: Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy in the form of radiation and communicate scientific ideas about the way stars, over their life cycle, produce elements.

AST 3.5: Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history (radiometric dating).

ALT4 - Bonding and IMF - Use data and models to describe the types and properties of chemical bonds, to inform the formulas of substances, to predict intermolecular forces, and to explain macro-level physical properties of substances.

AST 4.1: Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.

AST 4.2: Use principles of bonding and intermolecular forces to engineer a solution to a problem.

AST 4.3: Read and analyze information texts about bonding and intermolecular forces to answer relevant questions.

AST 4.4: Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials

AST 4.5: Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes

ALT5 - Reactions - Predict the products of simple chemical reactions, balance equations, construct explanations for observed reaction outcomes, and provide evidence for the conservation of mass.

AST 5.1: Conduct an investigation to construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.

AST 5.2: Use chemical reactions to design a solution to a real world problem.

AST 5.3: Read and analyze information texts about reactions to answer relevant questions.

AST 5.4: Classify reactions to Identify patterns in how compounds break apart and recombine, and balance reactions to demonstrate conservation of matter.

ALT6 - Stoichiometry - Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

AST 6.1: Plan and conduct an investigation that demonstrates conservation of mass involving the stoichiometry of a balanced chemical equation.

AST 6.3: I can read and analyze information texts about reactions and conservation of mass to answer relevant questions.

AST 6.4: Use mathematical representations to support to claim that atoms, and therefore mass, are conserved during a chemical reaction.

ALT7 - Thermochemistry and Bond Energy: Develop and use models to explain how energy is transferred between systems and surroundings in physical and chemical thermodynamic processes.

AST 7.1: Plan and conduct and investigation to provide that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniformed energy distributions among the components of in the system (second law of thermodynamics)

AST 7.2: Engineering - Hot and cold pack, pop-pop boats, immersion heating device to heat coffee, designing a heating and cooling system

AST 7.3: I can read and analyze informational texts about thermochemistry (bond energy) to answer relevant questions

AST 7.4: Develop a model to illustrate the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy

ALT8 - Rates and Equilibrium - Make predictions and construct explanations for the effects of changing reaction conditions on reaction rates and equilibria.

AST 8.1: Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.

AST 8.2: Refine the design of a chemical system by specifying a change in the conditions that would produce increased amounts of products at equilibrium.

AST 8.3: I can read and analyze information texts about reaction rates and equilibrium to answer relevant questions.

AST 8.4: Explain concept of pH, strong vs weak acids/bases, effects of concentration of hydrogen and hydroxide ions on pH, acid-base neutralization reactions.

ALT9 - Scientific Inquiry - Use the inquiry process as a controlled and data-driven means to investigate scientific questions.

AST 9.1: Formulate the question - Based on observations and science principles, I can formulate a question or hypothesis that can be investigated through the collection and analysis of relevant information.

AST 9.2: Design the Investigation - Design and conduct a controlled experiment, field study, or other investigation to make systematic observations about the natural world, including the collection of sufficient and appropriate data.

AST 9.3: Collect and Present Data - Collect, organize, and display sufficient and appropriate data to facilitate scientific analysis and interpretation.
AST 9.4: Analyze and Interpret Results - Summarize and analyze data to draw a valid and supported conclusion to communicate the findings of an investigation, and identify uncertainties.
AST 9.5: Knowledge and Technology Progression - Explain how technological problems and advances create a demand for new scientific knowledge and how new knowledge enables the creation of new technologies.

ALT10 - Engineering Design - Use the engineering design process as an iterative and productive means of problem solving.

AST 10.1: Identify and Define the Problem - I can describe a problem to be solved through the process of engineering, describe the relevant principles that relate to the problem, and identify appropriate criteria and constraints for a solution.
AST 10.2: Generate Possible Solutions - I can evaluate and select an engineering solution from a range of possible options and defend that solution for testing using trade-offs, criteria, and constraints.
AST 10.3: Test Solution(s) and Collect Data - I can test solution(s) by collecting, organizing, and displaying data to facilitate the analysis and interpretation of results.
AST 10.4: Analyze and Interpret Results - I can summarize and analyze data, evaluate the proposed solution, identify uncertainties, and suggest design improvements.
AST 10.5: Impacts of Technology - I can describe how new technologies enable new lines of scientific inquiry and are largely responsible for changes in how people live and work.

Biology Learning Targets 2019

<u>Biology ALT 1 - Ecosystems & Biodiversity</u> - Explains how ecosystems respond to disturbances and interactions

AST 1.1 Investigating Biodiversity: Plan and conduct an investigation that uses mathematical representations to support explanations about factors affecting biodiversity and populations in ecosystems of different scales. (HS-LS2-2)

AST 1.2 Human Impact: Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity. (HS-LS2-7)

AST 1.3 Informational Text: Read and use informational texts about ecological interactions and biodiversity.

AST 1.4 Carrying Capacity: Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales. (HS-LS2-1)

AST 1.5 Stability & Change: Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem. (HS-LS2-6)

<u>Biology ALT 2 – Biomolecules -</u> Explains how ecosystems respond to disturbances and interactions

AST 2.1 Investigating Enzymes: Analyze and interpret data about reaction rates to make conclusions about enzymes

AST 2.3 Informational Text: Read and use informational texts about cells or biomolecules to answer relevant questions

AST 2.4 Biomolecules: Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules. (HS-LS1-6)

AST 2.5 DNA to Trait: Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins, which carry out the essential functions of life through systems of specialized cells. (HS-LS1-1)

<u>Biology ALT 3 - Cells to Organisms</u> - Explains how cells are organized into organisms

AST 3.1 Investigating Homeostasis: Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis. (HS-LS1-3)

AST 3.3 Informational Text: Read and use informational texts about cells and organisms.

AST 3.4 Cell Development: Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms. (HS-LS1-4)

AST 3.5 Physiological Interactions: Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms. (HS-LS1-2)

<u>Biology ALT 4 - Genomics</u> - Explains how genes and the environment interact to determine traits in populations

AST 4.1 Investigating DNA and Traits: Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring. (HS-LS3-1)

AST 4.3 Informational Text: Read and use informational texts about genetics to answer relevant questions.

AST 4.4 Genetic Variation: Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors. (HS-LS3-2)

AST 4.5 Traits in Populations: Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population. (HS-LS3-3)

Biology ALT 5 – Evolution - Explains that all life is related and that populations change over time

AST 5.1 Investigating Trait Frequency: Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait. (HS-LS4-3)

AST 5.3 Informational Text: Read and use informational texts about evolution.

AST 5.4 Natural Selection: Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment. (HS-LS4-2)

AST 5.5 Adaptation: Construct an explanation based on evidence for how natural selection leads to adaptation of populations. (HS-LS4-4) (Cross-ref: Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.) (HS-LS2-8)

AST 5.6 Speciation: Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species. (HS-LS4-5)

AST 5.7 Evidence for Evolution: Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence. (HS-LS4-1)

Biology ALT 6- Carbon Cycle - Constructs a model to demonstrate how carbon is cycled

AST 6.1 Investigating Carbon Cycle: Develop a quantitative model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere. (HS-LS2-5 and HS-ESS2-6)

AST 6.3 Informational Text: Read and use informational texts about the cycling of carbon

AST 6.4 Photosynthesis: Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy. (HS-LS1-5)

AST 6.5 Respiration: Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy. (HS-LS1-7)

AST 6.6 Climate Change: Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems. (HS-ESS2-2)

Biology ALT 7- Ecological Matter and Energy - Explains how energy flows and matter cycles in ecosystems

AST 7.2 Human Impact: Evaluate, and refine a technological solution of reducing impacts of human activities on natural systems. (HS-ESS3-4)

Or

Sustainability: Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity (HS-ESS3-3)

AST 7.3 Informational Text: I can read and use informational texts about human impact on the environment.

AST 7.4 Aerobic vs. Anaerobic Respiration: Construct and revise an explanation based on evidence for the cycling

AST 7.5 Trophic Levels: Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem. (HS-LS2-4)

AST 7.6 Biogeography: Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth. (HS-ESS2-7)

Biology ALT 8 – Scientific Inquiry – Uses the inquiry process as a controlled and data-driven means to investigate scientific questions.

AST 8.1 Formulate the Question
Based on observations and science principles, formulates a question or hypothesis that can be investigated through the collection and analysis of relevant information.

AST 8.2 Design the Investigation
Designs and conducts a controlled experiment, field study, or other investigation to make systematic observations about the natural world, including the collection of sufficient and appropriate data.

AST 8.3 Collect and Present Data
Collects, organizes, and displays sufficient and appropriate data to facilitate scientific analysis and interpretation.

AST 8.4 Analyze and Interpret Results
Summarizes and analyzes data to draw a valid and supported conclusion to communicate the findings of an investigation, and identify uncertainties.

Biology ALT 9 - Engineering Design - Uses the engineering design process as an iterative and productive means of problem solving.

AST 9.1 Identify and Define the Problem
I can describe a problem to be solved through the process of engineering, describe the relevant principles that relate to the problem, and identify appropriate criteria and constraints for a solution.

AST 9.2 Generate Possible Solutions
I can evaluate and select an engineering solution from a range of possible options and defend that solution for testing using trade-offs, criteria, and constraints.

AST 9.3 Test Solution(s) and Collect Data
I can test solution(s) by collecting, organizing, and displaying data to facilitate the analysis and interpretation of results.

AST 9.4 Analyze and Interpret Results
I can summarize and analyze data, evaluate the proposed solution, identify uncertainties, and suggest design improvements.

AST 9.5 Evaluate a solution to a complex real-world problem based on prioritized criteria and tradeoffs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts (HS-ETS1-3)

High School Instructional Resources

The Patterns High School Science Sequence is a three-year course pathway and curriculum aligned to the Next Generation Science Standards (NGSS). The sequence consists of freshman physics, sophomore chemistry, and junior biology courses. Each course utilizes common instructional strategies and real-world phenomena and design challenges that engage students in rigorous learning experiences. The curriculum is a combination of teacher-generated and curated open-content materials.

Patterns Physics: Is a lab-based instructional resource for 9th grade Physics. Using the processes of scientific inquiry, engineering design, and critical thinking students discover and apply patterns in such major physics topics as motion, forces & momentum, energy, waves, and electromagnetism. An important aim of this resource is to develop and build students' math abilities, performance in problem solving, scientific literacy, and technical communication skills that will be built upon in future science courses, college, and career. This resource addresses all required physics, inquiry, and engineering standards as well as select earth and space science standards from the Next Generation Science Standards.

Patterns Chemistry: Is a lab-based instructional resource for 10th grade Chemistry. Using the processes of scientific inquiry, engineering design, and critical thinking students discover and apply patterns in such major chemistry topics as kinetic molecular theory, atomic structure, nuclear chemistry, bonding, chemical reactions, stoichiometry, equilibrium, and thermochemistry. This instructional resource builds on the skills developed in physics and expands the use of patterns to more complex functions and trends, also building on communication and technological skills. This resource addresses all required chemistry, inquiry, and engineering standards as well as select earth and space science standards from the Next Generation Science Standards.

Patterns Biology: Is a lab-based instructional resource for 11th grade Biology. Using the processes of scientific inquiry, engineering design, and critical thinking students discover and apply patterns in such major biology topics as ecological biodiversity, biomolecules, cells, the function and development of organisms, genomics, evolution, the carbon cycle, and matter and energy in ecosystems. This instructional resource builds on the skills developed in physics and chemistry and expands the use of statistical, technological, problem solving, and communication skills. This resource addresses all required life science, inquiry, and engineering standards as well as select earth and space science standards from the Next Generation Science Standards.

Textbooks:

In addition to the Patterns units of instruction, the Teacher Cadre has proposed we maintain the use of the physical textbooks from our last adoption, which are still in good condition and supply. These are primarily used for homework, reference, and supplementation. These texts are:

Course Name	**Textbook**
Physics 1/STEM Physics	Hewitt Conceptual Physics
Chemistry 1	Living by Chemistry
STEM Chemistry	Chemistry, by Wilbraham, et. al.
Biology 1	Biology, by Miller and Levine

High School Science and Engineering Equipment Plan:

A key component of teaching and learning science in the 21st Century classroom, and implementation of the Next Generation Science Standards is frequent student engagement in the practices of science and engineering. To provide these opportunities, our classrooms require the scientific and engineering equipment needed to conduct investigations and design solutions to real-world problems. Through the adoption process, each school will be provided the equipment needed to conduct the activities the Patterns units of instruction require in their classrooms. Vendors used for purchasing equipment will vary based on availability of function, quality and cost of items required.

High School Science Professional Development Plan

The Professional Development Plan is differentiated by course and informed by unit revision timelines and teacher input. All teachers will engage in professional development tailored to build their instructional capacity for equity, language support, supporting student engagement and academic discourse, and differentiation. In specific regards to supporting English Language Learners, science professional development will embed the instructional practices now being implemented through our English Language Development adoption, to ensure all high school science teachers are trained in sheltered instruction. These are topics teachers have expressed interest in through a feedback process conducted in the winter of 2019.

Physics and Chemistry teachers will engage in a two-day training, "Science Instructional Practices for Equity," focused on the topics listed above. This training will prepare Physics teachers to continue the unit refinement process as well as to hone their instructional practices. For chemistry, the training serves the additional purpose of providing teachers a common instructional grounding as they go into a deeper process of unit completion, alignment, and refinement. For teachers brand new to teaching physics and/or chemistry, they will be able to take a five-day course specific to that new subject so they can learn the labs and units for those courses, these courses are offered in the summer so they are prepared to teach in the fall. In ongoing years, the Instructional Practices for Science Equity training will be available for teachers new to the district.

For Biology, which has undergone more significant unit changes and the addition of new labs and engineering projects, more days will be needed to support teachers in learning about these changes and also embedding the same instructional practices as the Physics and Chemistry teacher training. Year 1 professional development for Biology teachers will be focused on ensuring all teachers have the knowledge and skills to implement their course(s) units of instruction and the research-based instructional practices that will best support their students in meeting the learning targets for those courses.

For year 1 and 2, each teacher will also have the opportunity to observe and be observed with sub days for classroom walkthroughs and collaboration time. These days will be a combination of observation and reflection. The purpose of these walkthroughs is for teachers to see the instructional practices developed in the initial training in action and to provide opportunities for teachers to collaborate and reflect with their peers. For an outline of this plan, see Appendix C.

Appendix A: High School Science Data

Science teachers began implementing the new science sequence in the 2012-2013 school year, starting with Physics. Chemistry and then Biology were then implemented in the 2013-2014 and 2014-2015 school years, respectively. The below are a few specific data measures we have used to evaluate the efficacy of our work in science over this period, including AP and IB science course enrollment, and test scores (including ACT, Explore, Plan, and Aspire)

Total AP/IB Science Enrollment Over Time

Cohort 1 of students who started their freshman year in Physics in 2012 were juniors in 2014. Junior year is the most common year that students start taking AP and IB courses, therefore 2014 would be the first year that we would expect to see a change in AP/IB science enrollment if it were correlated with the sequence implementation. As seen in Figure 1, enrollment did increase in 2014 compared to the prior four years and has continued to increase each subsequent year.

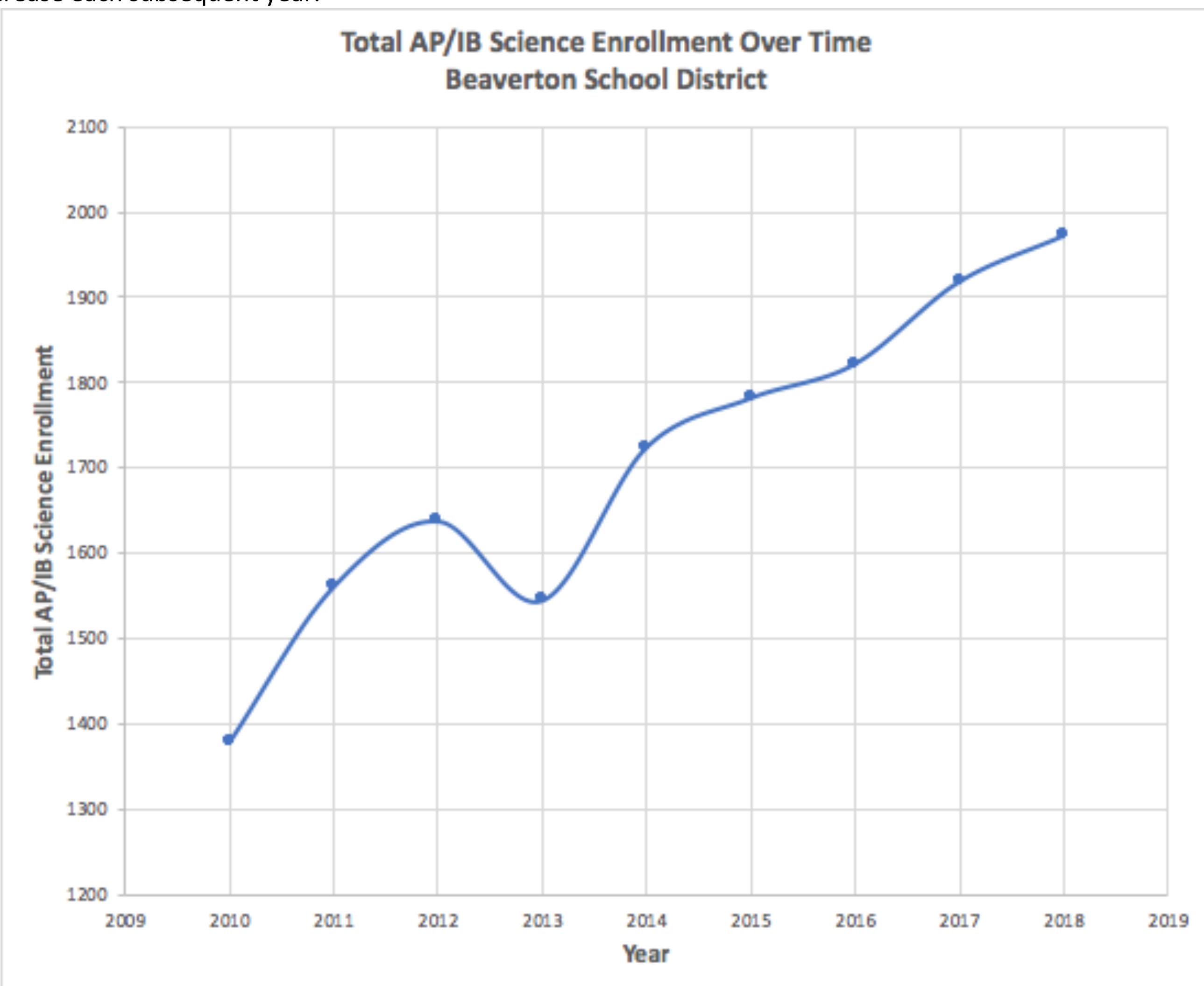

Figure 1

Percent Change in AP/IB Science Enrollment by Race/Ethnicity 2013 to 2018

For Figure 2, 2013 was chosen as a comparison year because it was the last year juniors (the most common year to begin taking AP/IB classes) had not yet had the sequence. The race/ethnicities with the largest gains were Hispanic and American Indian/Native Alaskan subgroups with increases of 51% and 50% respectively. Multiple, Asian, and Black/African American race/ethnicities had the next highest growth with 36%, 34%, and 33%, respectively. White and Native Hawaiian/Pacific Islander changed the least, at 18% and 13% respectively. All subgroups increased in AP/IB science enrollment. In the same timeframe, total district high school enrollment increased by 17%.

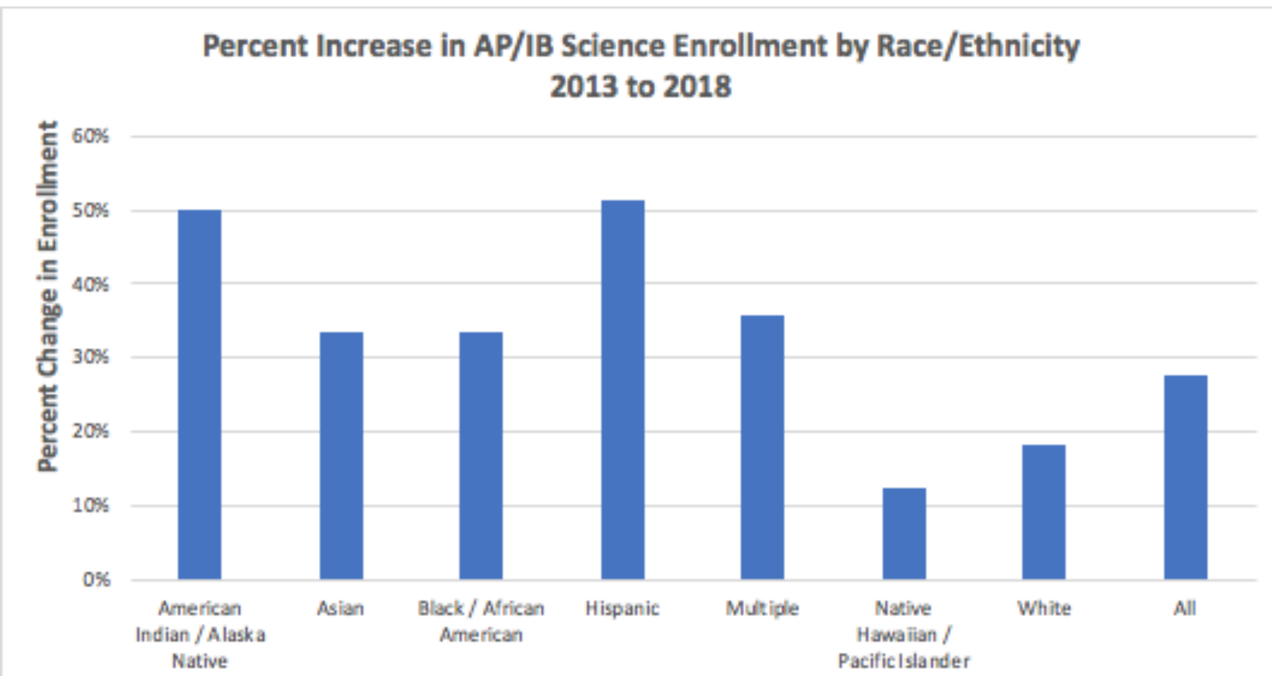

Figure 2

ACT Science Score Trends

Figure 3 displays the average ACT Science Score between 2012 and 2018, for Beaverton and also the national average. 2014 was the first year that students taking the ACT (juniors) had had the full sequence. Since then, the scores have increased and been at record highs (2016 and 2018), with the exception of 2017, were there was a dip in the Beaverton score. In comparison, the national average has been relatively flat, and reflects the scores of students who opt-in to the test, as it is not the national norm for all students to take the ACT. In comparison, nearly all Beaverton juniors take the ACT exam.

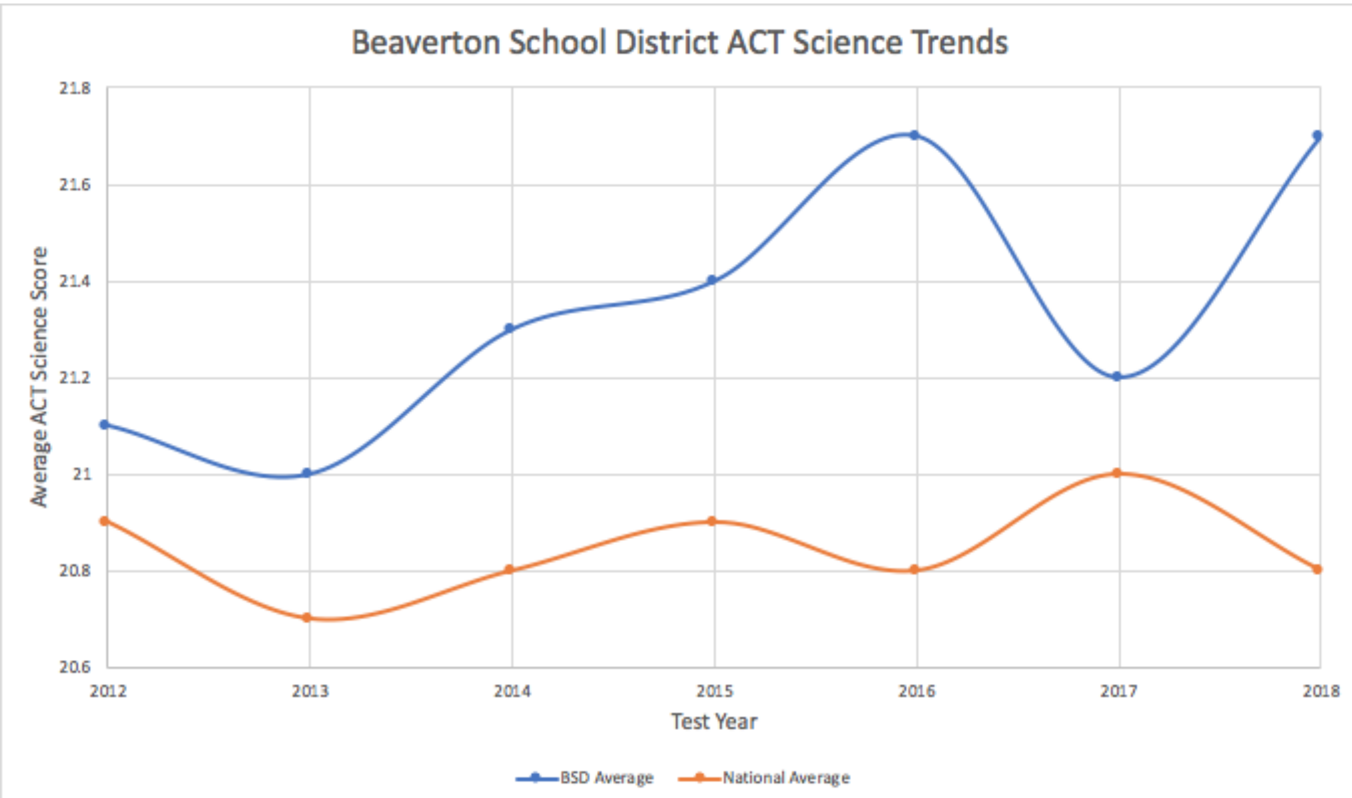

Figure 3

Figure 4 shows the average ACT science score over time disaggregated by race/ethnicity. From 2013 (pre-sequence) to 2018, scores have increased for all subgroups. Changes to the average ACT science score for each subgroup between 2013 and 2018, listed from largest to smallest, are the following: Multiple (+3.9), Asian (+1.6), Black (+1.3), Hispanic (+0.9), and White (+0.6).

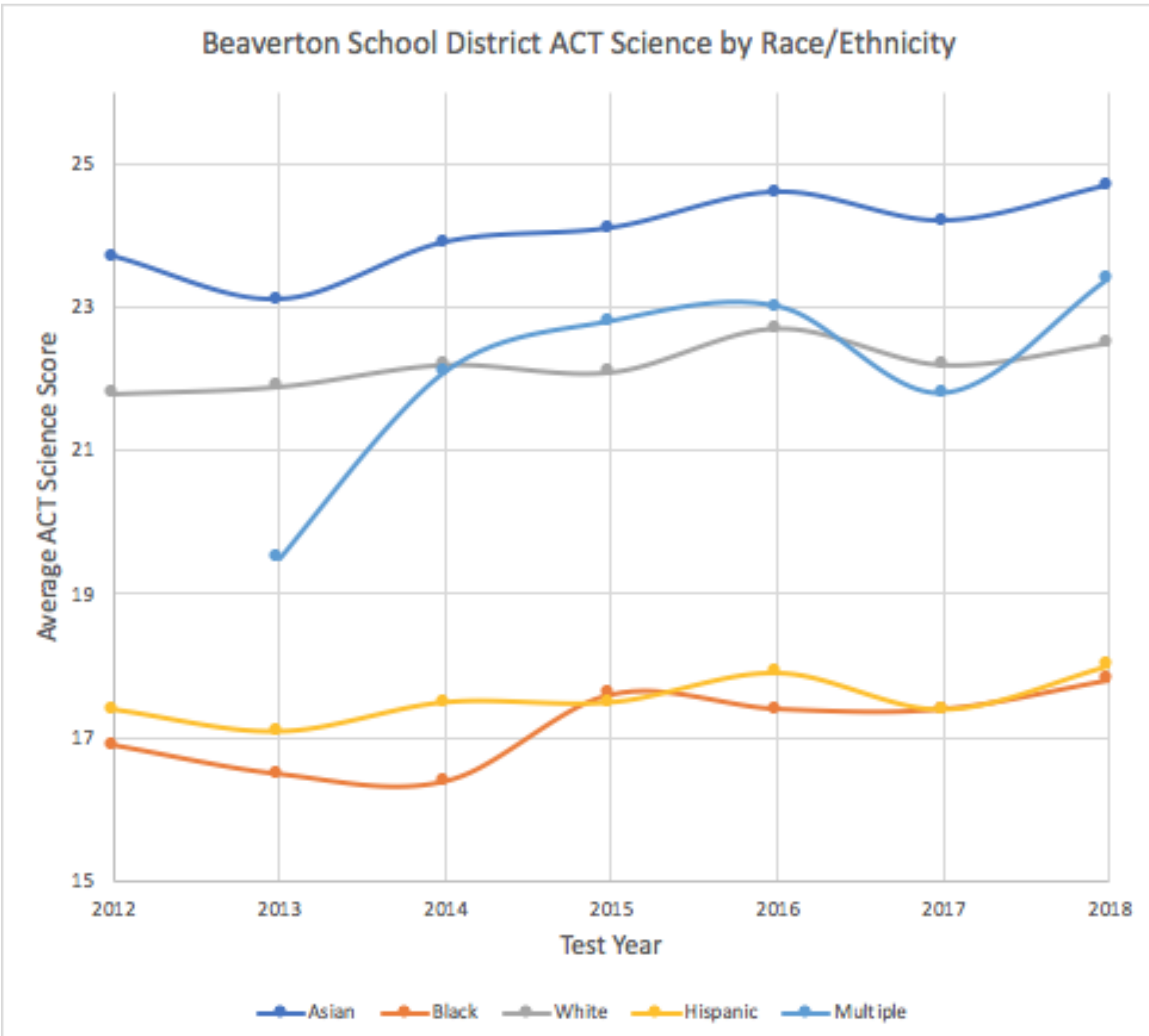

Figure 4

Appendix B: High School Instructional Materials Review Process

In April and May of 2018, the Science Teacher Cadre reviewed all instructional materials on the High School ODE Adoption List, in addition to the Patterns materials they were already using in their classrooms. The chemistry team did an additional review of materials in September 2018. Upon completion of their full review process, each course team on the Cadre noted the following:

- The textbooks on the ODE adoption lists were not significantly different than the textbooks we already own and are still in good condition:
    - **Physics**: Hewitt Conceptual Physics
    - **Chemistry 1:** Living by Chemistry
    - **STEM Chemistry:** Chemistry (Pearson, by Wilbraham, et. al.)
    - **Biology:** Miller and Levine Biology
- After reviewing the materials against the Equip Rubric (a nationally developed rubric to evaluate NGSS alignment of curricula) and our internal criteria, the ODE Adoption List materials were judged insufficiently aligned to the NGSS and the instructional goals for our courses.
- Teachers agreed that our own Patterns instructional materials were both high quality and would require substantially less money to continuously improve versus buying all new textbooks. This will allow us to allocate funds to purchase new lab equipment and to replace old and broken equipment across our schools. With the emphasis on the practicing of science and engineering in the NGSS, the Cadre and Project team wants to prioritize schools having the tools and materials for students to engage in science.

Appendix C: Professional Development Plan - Outline of Events

Teachers	Year 1, 2019-2020	Year 2, 2020-2021
Physics	2 day “Instructional Practices for Science Equity” training. Offered summer, July 18 and 19, or 2 days during the school year. 2 days “Physics Classroom Walkthroughs” teachers observe each other for a half day and reflect on observations for a half day.	2 days “Physics Classroom Walkthroughs” teachers observe each other for a half day and reflect on observations for a half day. 2 day “Instructional Practices for Science Equity” training for new teachers
Chemistry	2 day “Instructional Practices for Science Equity” training offered during the school year. 2 days “Chemistry Classroom Walkthroughs” teachers observe each other for a half day and reflect on observations for a half day.	2 days “Chemistry Classroom Walkthroughs” teachers observe each other for a half day and reflect on observations for a half day. 2 day “Instructional Practices for Science Equity” training for new teachers
Biology	5 days “Biology for the Next Generation” training. Offered summer, July 15-19 or August 12-16, or 5 days during the school year (spread out, based on unit timing). 1-day “Biology Classroom Walkthroughs” teachers observe each other for a half day and reflect on observations for a half day.	2 days “Biology Classroom Walkthroughs” teachers observe each other for a half day and reflect on observations for a half day. 2 day “Instructional Practices for Science Equity” training for new teachers

Appendix D: Best Practices References

1= Purpose **2**= Student Engagement **3**= Curriculum and Pedagogy **4**= Assessment **5**= Classroom Environment and Culture

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5D™	Subdimension	The Vision	Guiding Questions
Curriculum & Pedagogy	**Curriculum**	• Instructional materials (e.g., texts, resources, etc.) and tasks are appropriately challenging and supportive for all students, are aligned with the learning target and content area standards, and are culturally and academically relevant. • The lesson materials and tasks are related to a larger unit and to the sequence and development of conceptual understanding over time.	• How does the learning in the classroom reflect authentic ways of reading, writing, thinking and reasoning in the discipline under study? (e.g., How does the work reflect what mathematicians do and how they think?) • How does the content of the lesson (e.g., text or task) influence the intellectual demand (e.g. the thinking and reasoning required)? How does it align to grade-level standards? • How does the teacher scaffold the learning to provide all students with access to the intellectual work and to participation in meaning-making? • What does the instruction reveal about the teacher's understanding of how students learn, of disciplinary habits of thinking, and of content knowledge? • How is students' learning of content and transferable skills supported through the teacher's intentional use of instructional strategies and materials? • How does the teacher differentiate instruction for students with different learning needs—academic background, life experiences, culture and language?
	Teaching Approaches and/or Strategies	• The teacher makes decisions and utilizes instructional approaches in ways that intentionally support his/her instructional purposes. • Instruction reflects and is consistent with pedagogical content knowledge and is culturally responsive, in order to engage students in disciplinary habits of thinking. • The teacher uses different instructional strategies, based on planned and/or in-the-moment decisions, to address individual learning needs.	
	Scaffolds for Learning	• The teacher provides scaffolds for the learning task that support the development of the targeted concepts and skills and gradually releases responsibility, leading to student independence.	
Assessment for Student Learning	**Assessment**	• Students assess their own learning in relation to the learning target. • The teacher creates multiple assessment opportunities and expects all students to demonstrate learning. • Assessment methods include a variety of tools and approaches to gather comprehensive and quality information about the learning styles and needs of each student (e.g., anecdotal notes, conferring, student work samples, etc.). • The teacher uses observable systems and routines for recording and using student assessment data (e.g., charts, conferring records, portfolios, rubrics). • Assessment criteria, methods and purposes are transparent and match the learning target.	• How does the instruction provide opportunities for all students to demonstrate learning? How does the teacher capitalize on those opportunities for the purposes of assessment? • How does the teacher gather information about student learning? How comprehensive are the sources of data from which he/she draws? • How does the teacher's understanding of each student as a learner inform how the teacher pushes for depth and stretches boundaries of student thinking? • How do students use assessment data to set learning goals and gauge progress to increase ownership in their learning? • How does the teacher's instruction reflect planning for assessment? • How does the teacher use multiple forms of assessment to inform instruction and decision-making? • How does the teacher adjust instruction based on in-the-moment assessment of student understanding?
	Adjustments	• The teacher uses formative assessment data to make in-the-moment instructional adjustments, modify future lessons, and give targeted feedback to students.	
Classroom Environment & Culture	**Use of Physical Environment**	• The physical arrangement of the room (e.g., meeting area, resources, student seating, etc.) is conducive to student learning. • The teacher uses the physical space of the classroom to assess student understanding and support learning (e.g., teacher moves around the room to observe and confer with students). • Students have access to resources in the physical environment to support learning and independence (e.g., libraries, materials, charts, technology, etc.).	• How does the physical arrangement of the classroom, as well as the availability of resources and space to both the teacher and students, purposefully support and scaffold student learning? • How and to what extent do the systems and routines of the classroom facilitate student ownership and independence? • How and to what extent do the systems and routines of the classroom reflect values of community, inclusivity, equity and accountability for learning? • What is the climate for learning in this classroom? How do relationships (teacher-student, student-student) support or hinder student learning? • What do discourse and interactions reveal about what is valued in this classroom? • What are sources of status and authority in this classroom (e.g., reasoning and justification, intellectual risk-taking, popularity, aggressiveness, etc.)?
	Classroom Routines and Rituals	• Classroom systems and routines facilitate student responsibility, ownership and independence. • Available time is maximized in service of learning.	
	Classroom Culture	• Classroom discourse and interactions reflect high expectations and beliefs about all students' intellectual capabilities and create a culture of inclusivity, equity and accountability for learning. • Classroom norms encourage risk-taking, collaboration and respect for thinking.	

Appendix F: High School Instructional Resources Background & Instruction Model

Background: The Patterns High School Science Sequence is a three-year course pathway and curriculum aligned to the Next Generation Science Standards (NGSS). The sequence consists of freshman physics, sophomore chemistry, and junior biology courses. Each course utilizes common instructional strategies and real-world phenomena and design challenges that engage students in rigorous learning experiences. The curriculum is a combination of teacher-generated and curated open-content materials. Development of these materials began in the classrooms of Beaverton teachers and has grown steadily over the last 7 years. Development of the curriculum is now a regional effort in part supported by our STEM Hub, the Portland Metro STEM Partnership (PMSP), who have recently received several grants to support the curriculum and its development of career connections. Initially implemented in Beaverton between 2012 and 2014, the sequence has been continuously improved over time by teacher leaders and with the help and input of teachers across the district. To view data showing changes we have seen before and after implementation of the Patterns Sequence, including AP and IB science enrollment and science achievement on the ACT test, see Appendix A. For information on the review process the Teacher Cadre conducted to put forth this recommendation, see Appendix B.

Model of Instruction: The Patterns Approach to science instruction emphasizes the use of mathematical and real-world patterns to predict the future and understand the past. Students construct science knowledge by making an initial "wild-guess", asking questions, planning and conducting experiments, collecting data, finding a mathematical model that fits their data, explaining the phenomenon based on that model, then finally making a data-informed prediction. Harnessing their own experiences, students compare and contrast low-evidence predictions (wild guesses) to their data-informed prediction to live the scientific experience and learn the value of evidence-based reasoning. Additionally, students engage in several engineering projects in each course, where they must use patterns they discover in their designs to optimize solutions to real-world problems. The Patterns Approach utilizes technology, student-constructed knowledge, frequent opportunities for student talk, and language supports to ensure the engagement and success of every student. By emphasizing, rather than removing, the mathematical connections to science, the Patterns Approach supports student conceptual understanding by making connections between real-world inquiry experiences, graphical representations, and mathematical representations of science phenomena.