Malesus STEM Innovation Center

Tennessee Academic Math & Science Standards

At Malesus STEM Innovation Center we believe that the key to understanding STEM (Science, Technology, Engineering, Math) concepts is through cross-curricular integration and practical application of knowledge and skills by domain across multiple grade levels.

Tennessee Department of Education.

Cross-Curricular Key Instructional Dynamics

- **Progression**: Skills build from foundational arithmetic (6th) to abstract algebraic reasoning (8th).
- **Focus Areas**: Ratios and equations deepen into functions; geometry expands to include transformations and proof concepts.
- **Real-World Connections**: Problems emphasize financial literacy (taxes, interest) and data analysis.

For exact standards, refer to the Tennessee Academic Standards for Mathematics. This alignment reflects typical grade-level expectations but may vary slightly in specificity.

Here's a curated list of **Tennessee Science Standards** for grades 6–8 that align seamlessly with **Ratios & Proportional Relationships** math standards, structured for a cross-grade PBL project. The focus is on real-world applications of ratios, rates, proportions, and data analysis in scientific contexts:

6th Grade Science + Ratios & Proportions

Science Standards:

- **6.ESS2.5**: Analyze and interpret data to compare the distribution of Earth's saltwater and freshwater.

- **6.ESS3.3**: Evaluate design solutions for managing resource distribution (e.g., water, energy).
- **6.ESS2.4**: Investigate how water cycles through Earth's systems.

Math Connection:

- Calculate **ratios** of freshwater to saltwater availability globally.
- Compute **unit rates** for water usage (e.g., gallons per person/day).
- Use **percentages** to analyze conservation solutions.

PBL Idea:
Project: "Global Water Crisis Analysis"

- Collect data on local/global water distribution.
- Calculate ratios of usable freshwater vs. total water.
- Design a conservation plan using proportional reasoning (e.g., reducing usage by 20%).

7th Grade Science + Ratios & Proportions

Science Standards:

- **7.LS2.1**: Analyze how resource availability affects populations in ecosystems.
- **7.LS2.4**: Model ecosystem changes due to biotic/abiotic factors.
- **7.LS2.5**: Investigate biodiversity and ecosystem health.

Math Connection:

- Calculate **population ratios** (e.g., predator-prey relationships).
- Analyze **proportional changes** in biodiversity (e.g., species decline rates).
- Graph **proportional relationships** (e.g., plant growth vs. sunlight).

PBL Idea:
Project: "Ecosystem Balance Simulation"

- Track population data in a virtual ecosystem.
- Model predator-prey ratios and predict collapse/recovery.

- Use proportional reasoning to propose solutions for biodiversity loss.

8th Grade Science + Ratios & Proportions

Science Standards:

- **8.PS2.1**: Investigate forces and motion (speed, acceleration).
- **8.PS1.5**: Analyze chemical reactions (conservation of mass).
- **8.ESS3.1**: Interpret data on human impacts (e.g., carbon emissions).

Math Connection:

- Calculate **speed** (distance/time) and **density** (mass/volume).
- Use **proportions** to balance chemical equations (e.g., $2H_2 + O_2 \rightarrow 2H_2O$).
- Analyze **rates of change** in carbon emissions over time.

PBL Idea:
Project: "Energy Efficiency & Motion Lab"

- Test toy cars to calculate speed ratios (distance vs. time).
- Design fuel-efficient "vehicles" using proportional mass/energy relationships.
- Model carbon footprint reductions using linear equations.

Cross-Grade Collaborative PBL Theme:

Title: *"Sustainable Futures: From Ecosystems to Energy"*

- **6th Grade**: Analyze water/energy ratios and propose conservation plans.
- **7th Grade**: Model ecosystem stability using population proportions.
- **8th Grade**: Calculate carbon emission rates and engineer solutions.
- **Final Output**: A school-wide sustainability fair showcasing data-driven proposals.

Key Alignment Strategies:

1. **Data-Driven Analysis**: Use ratios to interpret scientific data (e.g., population trends, resource distribution).

2. **Modeling**: Graph proportional relationships (e.g., temperature vs. ice melt rates).
3. **Real-World Problem Solving**: Apply unit rates to design solutions (e.g., reducing water waste by 15%).

These standards naturally integrate proportional reasoning, allowing students to see math as a tool for scientific inquiry. For exact standards, refer to the Tennessee Science Standards.

Here's a breakdown of **Tennessee Science Standards domains** (6th–8th grade) that align most naturally with **The Number System** math standards, along with project ideas for cross-grade PBL integration. The Number System focuses on operations with integers, fractions, exponents, roots, and scientific notation, which pair well with science domains requiring quantitative analysis, measurement, and data interpretation.

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1. Earth & Space Science (6th Grade)

Science Domain:

- **6.ESS2: Earth's Systems** (e.g., water distribution, rock cycles, climate).
- **6.ESS3: Earth and Human Activity** (resource management, natural hazards).

Math Alignment:

- **Negative numbers**: Temperatures below zero, elevation depths.
- **Fractions/decimals**: Calculating percentages of Earth's freshwater vs. saltwater.
- **Unit conversions**: Converting between metric units (km to m, kg to g).

PBL Idea:
Project: "Planet Earth's Resource Audit"

- Calculate the **percentage** of accessible freshwater globally (e.g., 6.ESS2.5).
- Graph temperature changes (using negative numbers) in polar regions.
- Convert units to analyze resource extraction rates (e.g., barrels of oil to liters).

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2. Life Science (7th Grade)

Science Domain:

- **7.LS2: Ecosystems** (biodiversity, population dynamics).
- **7.LS3: Heredity** (genetics, Punnett squares).

Math Alignment:

- **Rational numbers**: Population growth/decline rates (e.g., +3.5% or -2.2%).
- **Ratios/proportions**: Predator-prey ratios or genetic probability (e.g., 1:2:1 in Mendelian genetics).
- **Scientific notation**: Representing large populations (e.g., 3.5×10^6 bacteria).

PBL Idea:
Project: "Ecosystem Census & Genetic Diversity"

- Track population changes in a local ecosystem using **positive/negative integers**.
- Calculate genetic probabilities (e.g., 25% chance of recessive traits) with fractions.
- Model bacterial growth using **exponents** (e.g., doubling every hour: 2^n).

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3. Physical Science (8th Grade)

Science Domain:

- **8.PS1: Matter and Its Interactions** (atomic structure, chemical equations).
- **8.PS2: Motion and Forces** (speed, acceleration).
- **8.ESS1: Space Systems** (distances in the solar system).

Math Alignment:

- **Scientific notation**: Atomic sizes (e.g., 1×10^{-10} m) or planetary distances.
- **Exponents/roots**: Calculating kinetic energy ($\frac{1}{2}mv^2$) or gravitational force.
- **Integer operations**: Balancing chemical equations (e.g., $2H_2 + O_2 \rightarrow 2H_2O$).

PBL Idea:
Project: "Mission to Mars: Engineering Survival"

- Use **scientific notation** to compare Earth/Mars distances or atomic structures.
- Calculate rocket fuel needs using **exponents** (e.g., combustion reactions).

- Balance chemical equations with **integer coefficients** to model life-support systems.

Cross-Grade PBL Theme:

Title: *"Numbers in Nature: From Cells to Space"*

- **6th Grade**: Audit Earth's resources using fractions, decimals, and negative numbers.
- **7th Grade**: Model ecosystems and genetics with ratios and rational numbers.
- **8th Grade**: Design space missions using exponents, roots, and scientific notation.
- **Final Output**: A collaborative "Numbers in Nature" exhibit showcasing calculations across scales (atomic to planetary).

Key Connections:

Science Domain	Number System Skill	Example
Earth Systems	Fractions/percentages	3% of Earth's water is freshwater.
Ecosystems	Positive/negative rational numbers	A -15% decline in bee populations.
Matter & Motion	Exponents/scientific notation	Speed of light = 3×10^8 m/s.

Why These Domains Work:

1. **Quantitative Focus**: Each domain requires measurement, unit conversions, or data analysis.
2. **Real-World Context**: Students apply number sense to tangible problems (e.g., climate change, genetics, space travel).
3. **Scaffolded Complexity**: Math progresses from basic fractions (6th) to exponents (8th), mirroring science concepts' increasing sophistication.

For detailed standards, visit the Tennessee Science Standards.

Here's a targeted alignment of **Tennessee Science Standards domains** (6th–8th grade) with the **Expressions & Equations** math domain, which focuses on algebraic reasoning, solving equations, and modeling relationships. These science domains naturally lend themselves to projects requiring students to write, manipulate, and analyze equations in real-world contexts:

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1. Physical Science (6th Grade)

Science Domain:

- **6.PS3: Energy** (e.g., thermal energy transfer, conservation of energy).
- **6.PS4: Waves** (e.g., light, sound, energy transfer).

Math Alignment:

- **Writing expressions**: Model energy transfer (e.g., Q=mcΔTQ=*mc*Δ*T* simplified for middle school).
- **Solving equations**: Calculate wave speed (speed=frequency×wavelengthspeed=frequency×wavelength).
- **Variables**: Analyze how variables like mass or temperature affect energy outcomes.

PBL Idea:
Project: "Energy Efficiency Lab"

- Design an experiment to test thermal insulation materials.
- Write equations to predict heat loss (Heat Lost=k·A·ΔTHeat Lost=*k*·*A*·Δ*T*).
- Solve for variables (e.g., "What thickness reduces heat loss by 30%?").

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2. Life Science (7th Grade)

Science Domain:

- **7.LS1: From Molecules to Organisms** (e.g., photosynthesis, cellular respiration).
- **7.LS2: Ecosystems** (e.g., population dynamics, food webs).

Math Alignment:

- **Linear expressions**: Model photosynthesis (Glucose=6CO2+6H2O→C6H12O6+6O2Glucose=6CO2+6H2O→C6H12O6+6O2).
- **Inequalities**: Determine carrying capacity (e.g., "If a forest can support 100 deer, write an inequality for sustainable population").
- **Multi-step equations**: Calculate energy transfer efficiency in food chains (e.g., 10% rule).

PBL Idea:
Project: "Ecosystem Equations"

- Create a mathematical model of a food web.
- Write equations to predict population changes if a species is removed.
- Solve inequalities to determine sustainable resource limits.

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3. Earth & Space Science (8th Grade)

Science Domain:

- **8.ESS1: Earth's Place in the Universe** (e.g., lunar phases, gravity).
- **8.ESS3: Earth and Human Activity** (e.g., climate change, carbon cycles).

Math Alignment:

- **Linear equations**: Model orbital periods (T2∝r3$T2 \propto r3$ simplified).
- **Systems of equations**: Analyze CO_2 emissions vs. sequestration rates.
- **Exponents**: Calculate gravitational force (F=Gm1m2r2$F = Gr2m1m2$, simplified with exponents).

PBL Idea:
Project: "Climate Crisis Calculator"

- Use equations to predict temperature rise based on CO_2 emissions.
- Solve systems of equations to balance emission reduction strategies.
- Graph linear relationships between deforestation and atmospheric CO_2.

Cross-Grade Collaborative PBL Theme:

Title: *"Equations for a Sustainable Planet"*

- **6th Grade**: Design energy-efficient solutions using thermal equations.
- **7th Grade**: Model ecosystems with algebraic expressions to ensure biodiversity.
- **8th Grade**: Predict climate outcomes with linear and exponential equations.
- **Final Output**: A "Sustainability Symposium" where teams present data-driven models to reduce environmental impact.

Key Connections:

Science Domain	Expressions & Equations Skill	Example
Energy (6th)	Writing/solving equations	Solve $500=0.5 \cdot m \cdot 10$ for mass.
Photosynthesis (7th)	Balancing chemical equations	$6CO_2+6H_2O \rightarrow C_6H_{12}O_6+6O_2$
Climate Change (8th)	Systems of equations	Solve $x+y=100$ and $2x-y=40$ for emission targets.

Why These Domains Work:

1. **Algebraic Modeling**: Each domain requires translating scientific relationships (e.g., energy transfer, population growth) into equations.
2. **Real-World Problem Solving**: Students use equations to design solutions (e.g., sustainable ecosystems, carbon reduction plans).
3. **Progression**:
    - **6th**: Basic equations (e.g., thermal energy).
    - **7th**: Multi-step equations and inequalities (e.g., carrying capacity).
    - **8th**: Systems and nonlinear relationships (e.g., climate models).

For detailed standards, refer to the Tennessee Science Standards. These projects empower students to see algebra as a tool for understanding and improving the natural world!

Here's a targeted alignment of **Tennessee Science Standards domains** (6th–8th grade) with the **Geometry** math domain, which focuses on shapes, area, volume, transformations, coordinate systems, and spatial reasoning. These science domains naturally integrate geometric concepts, making them ideal for cross-disciplinary PBL projects:

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1. Earth & Space Science (6th Grade)

Science Domain:

- **6.ESS2: Earth's Systems** (e.g., rock layers, water distribution, climate patterns).
- **6.ESS3: Earth and Human Activity** (e.g., natural hazard mitigation, resource management).

Geometry Alignment:

- **Area/Volume**: Calculate the volume of water in reservoirs or the area of deforestation.
- **Coordinate Planes**: Plot earthquake epicenters or hurricane paths using latitude/longitude.
- **Surface Area**: Model how surface area affects erosion rates (e.g., soil vs. bedrock).

PBL Idea:
Project: "Disaster-Proof City Design"

- Design a flood-resistant city using **volume calculations** for levees or drainage systems.
- Plot historical earthquake data on a **coordinate plane** to identify safe zones.
- Calculate the **surface area** of different materials to test erosion resistance.

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2. Life Science (7th Grade)

Science Domain:

- **7.LS1: From Molecules to Organisms** (e.g., cell structures, plant/animal anatomy).
- **7.LS2: Ecosystems** (e.g., food webs, symbiotic relationships).

Geometry Alignment:

- **Scale Drawings**: Create scaled models of cells, organs, or ecosystems.
- **Angles**: Study leaf angles for sunlight optimization or animal joint mechanics.
- **Circles**: Calculate the **circumference** and **area** of tree trunks to estimate age/biomass.

PBL Idea:
Project: "Biome Blueprint"

- Build a **scale model** of a biome (e.g., rainforest canopy) with geometric shapes.

- Measure **angles** of plant stems or animal limbs to analyze biomechanics.
- Use **circle geometry** to model population spread in a habitat.

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3. Physical Science (8th Grade)

Science Domain:

- **8.PS2: Motion and Forces** (e.g., speed, collisions, trajectories).
- **8.PS4: Waves** (e.g., light, sound, energy transfer).
- **8.ETS1: Engineering Design** (e.g., prototyping, optimization).

Geometry Alignment:

- **Transformations**: Model wave reflections, refractions, or sound echoes.
- **Pythagorean Theorem**: Calculate distances in projectile motion (e.g., a ball's trajectory).
- **Volume**: Design containers for chemical reactions (conservation of mass).
- **Congruence/Similarity**: Test structural stability in bridges or towers.

PBL Idea:
Project: "Physics Park: Motion & Structures"

- Design a roller coaster using **transformations** (rotations, reflections) for track loops.
- Apply the **Pythagorean Theorem** to model parabolic jumps or collision paths.
- Build earthquake-resistant structures and test **congruence/similarity** under stress.

Cross-Grade Collaborative PBL Theme:

Title: *"Geometry in Nature and Engineering"*

- **6th Grade**: Use coordinate planes and volume calculations to map natural disasters and design solutions.
- **7th Grade**: Create scale models of biological systems (e.g., cells, ecosystems).
- **8th Grade**: Engineer structures or motion systems using transformations and the Pythagorean Theorem.
- **Final Output**: A "Geometry Expo" showcasing models, blueprints, and simulations.

Key Connections:

Science Domain	Geometry Skill	Example
Earth's Systems (6th)	Area/Volume	Calculate the cubic meters of soil eroded from a hillside.
Cell Structures (7th)	Scale Drawings	Draw a 1000x scaled plant cell using hexagons and circles.

Science Domain	Geometry Skill	Example
Motion (8th)	Pythagorean Theorem	Find the diagonal distance of a ball's trajectory: a2+b2=c2$a_2+b_2=c_2$.

Why These Domains Work:

1. **Spatial Reasoning**: Earth science (maps), life science (anatomy), and physics (motion) all require visualizing and modeling 2D/3D structures.
2. **Real-World Design**: Geometry skills directly apply to engineering challenges (e.g., disaster-proof cities, biome models, roller coasters).
3. **Hands-On Learning**: Projects like building scale models or calculating trajectories make abstract geometry tangible.

For detailed standards, refer to the Tennessee Science Standards and Math Standards. These projects empower students to see geometry as the "language" of the natural and engineered world!

Here's a streamlined alignment of **Tennessee Science Standards domains** (6th–8th grade) with the **Statistics & Probability** math domain, which focuses on data analysis, variability, inference, and probability. These science domains naturally integrate statistical reasoning, making them ideal for cross-disciplinary PBL projects:

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1. Earth & Space Science (6th Grade)

Science Standards:

- **6.ESS2: Earth's Systems** (e.g., climate patterns, natural disasters).
- **6.ESS3: Earth and Human Activity** (e.g., human impacts on the environment).

Statistics & Probability Alignment:

- **Data Analysis**: Track temperature, precipitation, or pollution levels over time.
- **Measures of Center/Spread**: Calculate mean rainfall or variability in earthquake magnitudes.
- **Probability**: Predict the likelihood of extreme weather events (e.g., hurricanes).

PBL Idea:
Project: "Climate Detectives"

- Collect and analyze historical climate data (e.g., temperature, CO_2 levels).
- Create **box plots** or **histograms** to compare decades.

- Use probability to forecast future climate trends and propose mitigation strategies.

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2. Life Science (7th Grade)

Science Standards:

- **7.LS2: Ecosystems** (e.g., biodiversity, population dynamics).
- **7.LS3: Heredity** (e.g., genetic variation, Punnett squares).

Statistics & Probability Alignment:

- **Random Sampling**: Estimate species populations using quadrat sampling.
- **Probability**: Model genetic inheritance (e.g., 25% chance of recessive traits).
- **Comparing Populations**: Use **mean** and **IQR** to contrast biodiversity in two ecosystems.

PBL Idea:
Project: "Biodiversity Crisis Lab"

- Conduct field studies (real or simulated) to collect species data.
- Calculate probabilities of species extinction based on habitat loss.
- Design **scatter plots** to correlate biodiversity with environmental factors.

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3. Physical Science (8th Grade)

Science Standards:

- **8.PS2: Motion and Forces** (e.g., speed, acceleration).
- **8.PS4: Waves** (e.g., light, sound).
- **8.ESS3: Human Impacts** (e.g., energy consumption, pollution).

Statistics & Probability Alignment:

- **Correlation**: Analyze relationships between variables (e.g., force vs. acceleration).
- **Probability Models**: Predict experimental outcomes (e.g., likelihood of a successful design).

- **Statistical Significance**: Compare energy-efficient solutions using hypothesis testing.

PBL Idea:
Project: "Green Energy Experiment"

- Test solar panel efficiency under different conditions (angle, light intensity).
- Use **scatter plots** and **lines of best fit** to model data.
- Calculate probabilities for optimizing renewable energy systems.

Cross-Grade Collaborative PBL Theme:

Title: *"Data-Driven Planet Protectors"*

- **6th Grade**: Analyze climate data to identify environmental threats.
- **7th Grade**: Investigate biodiversity loss and genetic diversity trends.
- **8th Grade**: Engineer solutions using statistical evidence (e.g., renewable energy systems).
- **Final Output**: A community "Data Summit" presenting actionable insights with visualizations (infographics, interactive graphs).

Key Connections:

Science Domain	Statistics & Probability Skill	Example
Climate (6th)	Measures of variability	Calculate the range of annual temperatures over 50 years.
Ecosystems (7th)	Probability in genetics	Predict offspring traits using Punnett squares (e.g., 75% dominant).
Motion (8th)	Correlation analysis	Determine if increased force correlates linearly with acceleration.

Why These Domains Work:

1. **Data-Rich Content**: Each domain requires collecting, organizing, and interpreting quantitative data (e.g., climate records, species counts, experimental results).
2. **Real-World Relevance**: Students use statistics to address pressing issues like climate change, biodiversity loss, and sustainable energy.
3. **Progression**:
    - **6th**: Foundational data collection and descriptive stats (mean, median, range).
    - **7th**: Probability and comparative analysis (box plots, random sampling).
    - **8th**: Advanced inference and modeling (correlation, hypothesis testing).

Tools & Resources:

- **6th**: NOAA climate databases, Google Earth for mapping.
- **7th**: iNaturalist for biodiversity tracking, virtual lab simulations.
- **8th**: PhET Interactive Simulations for motion/waves, TinkerCAD for engineering design.

By integrating these domains, students see statistics as a tool for scientific inquiry and societal problem-solving. For detailed standards, visit the Tennessee Science Standards.

Here's a targeted alignment of **Tennessee Science Standards** (6th–8th grades) with the **8th Grade Functions Domain** (defining, analyzing, and modeling linear/nonlinear relationships). These science domains naturally involve **variables, rates of change, and functional relationships**, making them ideal for a cross-grade PBL project where 8th graders lead the mathematical modeling while incorporating foundational concepts from 6th and 7th grades:

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1. 6th Grade Science: Earth & Space Science

Key Standards:

- **6.ESS2.4**: Investigate the water cycle and energy transfer in Earth's systems.
- **6.ESS3.5**: Analyze human impacts on climate (e.g., CO_2 emissions and temperature rise).

Functions Connection:

- Collect data on variables like **temperature**, **precipitation**, or **CO_2 levels** over time.
- Use **linear functions** to model trends (e.g., "If CO_2 increases by 2 ppm/year, predict future levels").

Role in PBL:

- **6th Graders**: Track and graph historical climate data (e.g., monthly rainfall or temperature).
- **8th Graders**: Transform this data into linear functions to predict future climate scenarios.

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2. 7th Grade Science: Life Science

Key Standards:

- **7.LS2.1**: Analyze how resource availability affects organism populations.
- **7.LS2.4**: Model ecosystem changes (e.g., predator-prey dynamics).

Functions Connection:

- Model population growth/decline as **linear or exponential functions**.
- Analyze how variables like food supply or predation rate affect population trends.

Role in PBL:

- **7th Graders**: Simulate predator-prey interactions (e.g., wolves vs. deer) and collect data.
- **8th Graders**: Use functions to represent relationships (e.g., y=mx+b$y=mx+b$ for linear growth, y=abx$y=abx$ for exponential decay).

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3. 8th Grade Science: Physical Science

Key Standards:

- **8.PS2.1**: Investigate motion and forces (speed, velocity, acceleration).
- **8.PS2.4**: Explore energy transfer (e.g., kinetic vs. potential energy).

Functions Connection:

- Model motion with **linear functions** (constant speed) or **quadratic functions** (acceleration).
- Graph relationships like distance vs. time or force vs. acceleration.

Role in PBL:

- **8th Graders**: Design experiments (e.g., toy car races) to collect data on speed/acceleration.
- Use functions to predict outcomes (e.g., "If acceleration doubles, how does stopping distance change?").

Cross-Grade PBL Theme:

Title: *"Functions in Action: From Ecosystems to Energy"*

- **6th Grade Focus**: Climate data collection (e.g., temperature, CO_2).
- **7th Grade Focus**: Population dynamics in ecosystems.
- **8th Grade Focus**: Modeling relationships with functions (linear, exponential, quadratic).
- **Final Output**: A collaborative report or presentation showing how functions predict real-world phenomena, with 8th graders leading the mathematical analysis.

Example Project:

"Predicting Planetary Change"

1. **6th Graders**: Track local weather data and global CO_2 levels (National Oceanic and Atmospheric Administration (NOAA) databases).
2. **7th Graders**: Research a species' population trends (e.g., bees, coral reefs) and identify threats.
3. **8th Graders**:
    - Create **linear functions** to model CO_2 growth and temperature rise.
    - Use **exponential functions** to predict species population collapse/recovery.

- Design **piecewise functions** to show how human interventions (e.g., emission reductions) alter trends.

Key Science-Math Alignments:

Science Topic	Function Type	8th Grade Math Standard
Climate Change (6th)	Linear (y=mx+by=mx+b)	8.F.B.4: Construct functions to model relationships.
Predator-Prey Dynamics (7th)	Exponential (y=abxy=abx)	8.F.A.3: Interpret nonlinear functions.
Motion & Energy (8th)	Quadratic (y=ax2y=ax2)	8.F.B.5: Describe qualitative features of functions.

Why This Works:

1. **Progressive Complexity**:
   - 6th/7th graders gather foundational data, while 8th graders apply abstract function modeling.
   - Functions evolve from simple linear (climate) to nonlinear (ecosystems, motion).
2. **Real-World Relevance**: Students see math as a tool to address issues like climate change, biodiversity loss, and energy efficiency.
3. **Collaborative Learning**: Younger grades contribute data, older grades analyze it—mirroring real scientific teamwork.

For detailed standards, refer to the Tennessee Science Standards and Math Standards. This approach bridges math and science while empowering students to think like data-driven problem solvers!

Project-Based Learning (PBL) Outline: Designing a Sustainable Community
Grades 6–8 | Tennessee Math & Science Standards Integration

Driving Question

"How can we design a sustainable community to minimize environmental impact and optimize resource use?"

Standards Addressed

Math:

- **6th Grade:** Ratios, area/volume, statistics (6.RP.A, 6.G.A, 6.SP.A).
- **7th Grade:** Proportional relationships, percentages, scale drawings (7.RP.A, 7.G.A).
- **8th Grade:** Linear equations, functions, geometric transformations (8.EE.B, 8.F.A, 8.G.A).

Science:

- **6th Grade:** Ecosystems, weather/climate, human impact (6.LS2, 6.ESS2, 6.ESS3).
- **7th Grade:** Energy/matter cycles, engineering solutions (7.PS3, 7.LS1, 7.ETS1).
- **8th Grade:** Earth's systems, engineering design (8.ESS3, 8.ETS1).

Project Phases

Phase 1: Research & Analysis (2 Weeks)

- **6th Grade Tasks:**
    - *Science:* Study local ecosystems and climate data. Analyze human impacts (6.ESS3).
    - *Math:* Create ratio-based infographics on resource use (e.g., water/person) (6.RP.A).
- **7th Grade Tasks:**
    - *Science:* Investigate energy consumption patterns and renewable energy options (7.PS3).
    - *Math:* Calculate proportional energy savings using solar/wind (7.RP.A).
- **8th Grade Tasks:**

- *Science:* Research Earth's systems (e.g., water cycles, soil health) (8.ESS3).
- *Math:* Model population growth with linear equations (8.F.A).

Deliverable: Collaborative report summarizing findings.

Phase 2: Design & Modeling (3 Weeks)

- **6th Grade Tasks:**
  - *Science:* Propose green spaces to support local biodiversity (6.LS2).
  - *Math:* Use area/volume to design community gardens (6.G.A).
- **7th Grade Tasks:**
  - *Science:* Engineer a waste-to-energy system (7.ETS1).
  - *Math:* Create scale drawings of infrastructure (7.G.A).
- **8th Grade Tasks:**
  - *Science:* Design earthquake-resistant buildings using Earth's systems data (8.ETS1).
  - *Math:* Apply geometric transformations to optimize land use (8.G.A).

Deliverable: 3D models/digital simulations of sustainable community sections.

Phase 3: Presentation & Advocacy (1 Week)

- **Cross-Grade Collaboration:**
  - Combine models/reports into a full community blueprint.
  - Develop cost-benefit analyses and persuasive presentations.
- **Math Integration:**
  - 6th: Statistical graphs for ecosystem health.
  - 7th: Proportional cost savings.
  - 8th: Predictive functions for long-term sustainability.
- **Science Integration:**

    - Address TN standards through solutions like rainwater harvesting (6th), solar grids (7th), and geothermal energy (8th).

Final Deliverable: Community town hall presentation to stakeholders (peers, teachers, local leaders).

Assessment

- **Rubrics:** Criteria include accuracy of math calculations, depth of science integration, creativity, and collaboration.
- **Peer Feedback:** Cross-grade evaluations of model functionality.
- **Reflection:** Students journal how their work addresses real-world challenges.

Resources & Tools

- Digital tools (Google Earth, Tinkercad).
- Recycled materials for physical models.
- Local environmental data sets.

Extensions

- Partner with a local sustainability organization for real-world input.
- Compete in a statewide "Green Community Design Challenge."

This PBL fosters interdisciplinary learning, civic engagement, and grade-specific skill mastery while addressing critical TN standards. 🌎 ✨

Designing projects that integrate **6th, 7th, and 8th Grade Tennessee Math and Science Standards** can help students see the connections between subjects and apply their learning to real-world problems. Below are three interdisciplinary project ideas that align with TN standards and encourage collaboration, critical thinking, and creativity.

Project 1: Sustainable City Design

Theme: Engineering and Environmental Science
Grades: 6th, 7th, and 8th
Standards Integrated:

- **Math**: Ratios, Geometry, Expressions and Equations, Statistics
- **Science**: Earth's Systems, Earth and Human Activity, Engineering Design

Project Description:
Students work in teams to design a sustainable city that minimizes environmental impact while meeting the needs of its residents.

Tasks:

1. **6th Grade**:
    - Use ratios to calculate the proportion of green spaces, residential areas, and commercial zones.
    - Calculate the area and volume of buildings and parks using geometry.
    - Analyze data on resource usage (e.g., water, energy) and summarize findings using statistics.
2. **7th Grade**:
    - Apply proportional reasoning to design energy-efficient systems (e.g., solar panels, wind turbines).
    - Use equations to model the cost and benefits of sustainable practices (e.g., recycling programs).
    - Investigate how human activities impact Earth's systems and propose solutions.
3. **8th Grade**:
    - Use the Pythagorean Theorem to design efficient road systems.
    - Analyze bivariate data (e.g., population growth vs. resource consumption) to predict future needs.
    - Apply engineering design principles to create a prototype of a sustainable building or system.

Deliverables:

- A scaled model or digital design of the city.
- A report explaining the mathematical and scientific principles used.
- A presentation to "city planners" (classmates or teachers) defending the design choices.

Project 2: Climate Change and Its Impact

Theme: Data Analysis and Environmental Science
Grades: 6th, 7th, and 8th
Standards Integrated:

- **Math**: Statistics, Ratios, Expressions and Equations
- **Science**: Earth's Systems, Ecosystems, Earth and Human Activity

Project Description:
Students investigate the causes and effects of climate change and propose solutions to mitigate its impact.

Tasks:

1. **6th Grade**:
    - Collect and analyze data on temperature changes, rainfall, or carbon emissions over time.
    - Use ratios to compare data across different regions or time periods.
    - Summarize findings using measures of central tendency and variability.
2. **7th Grade**:
    - Use proportional reasoning to analyze the relationship between human activities (e.g., deforestation, fossil fuel use) and climate change.
    - Create equations to model the impact of proposed solutions (e.g., reducing emissions by 10%).
    - Investigate how climate change affects ecosystems and biodiversity.
3. **8th Grade**:
    - Analyze bivariate data (e.g., temperature vs. ice melt) to identify trends and correlations.

- Use functions to predict future climate scenarios based on current data.
- Design and present a solution (e.g., a community action plan) to address climate change.

Deliverables:

- A data report with graphs and statistical analysis.
- A mathematical model predicting future impacts.
- A multimedia presentation proposing solutions.

Project 3: Rocket Science and Space Exploration

Theme: Physics and Engineering
Grades: 6th, 7th, and 8th
Standards Integrated:

- **Math**: Ratios, Geometry, Expressions and Equations, Functions
- **Science**: Energy, Waves, Engineering Design

Project Description:
Students design and launch a model rocket while exploring the science and math behind space exploration.

Tasks:

1. **6th Grade**:
   - Use ratios to calculate the scale of the model rocket compared to a real rocket.
   - Calculate the surface area and volume of the rocket using geometry.
   - Analyze data from test launches to improve the design.
2. **7th Grade**:
   - Apply proportional reasoning to optimize the rocket's design (e.g., fuel-to-weight ratio).
   - Use equations to calculate the rocket's trajectory and maximum height.
   - Investigate the energy transfer involved in launching the rocket.

3. **8th Grade**:
    - Use the Pythagorean Theorem to calculate distances in a simulated space mission.
    - Analyze bivariate data (e.g., launch angle vs. distance) to optimize performance.
    - Apply engineering design principles to refine the rocket and solve problems.

Deliverables:

- A working model rocket.
- A report detailing the math and science behind the design.
- A presentation explaining the launch results and improvements.

General Tips for Implementation

1. **Collaborative Groups**: Mix students from different grades to encourage peer learning and mentorship.
2. **Real-World Connections**: Use local issues or global challenges to make the projects relevant.
3. **Hands-On Activities**: Incorporate experiments, models, and technology to engage students.
4. **Cross-Curricular Links**: Include elements of writing, art, or social studies to broaden the scope.
5. **Assessment**: Use rubrics to evaluate both the process (collaboration, problem-solving) and the final product (accuracy, creativity).

These projects not only align with TN Math and Science Standards but also foster 21st-century skills like collaboration, critical thinking, and communication. For more details on the standards, visit the Tennessee Department of Education website.

Science and Math

6th, 7th, and 8th grades by domain, highlighting the progression across grade levels:

Life Science (LS)

6th Grade	7th Grade	8th Grade
Ecosystems, food webs, biodiversity	Cell structure, function, and processes	Genetics, heredity, DNA
Interactions among organisms (symbiosis)	Human body systems (e.g., circulatory, respiratory)	Evolution, natural selection, adaptations
Biomes and environmental adaptations	Sexual/asexual reproduction and heredity basics	Biodiversity and classification

Physical Science (PS)

6th Grade	7th Grade	8th Grade
Energy transfer (thermal, light, motion)	Properties of matter (elements, compounds)	Forces, motion, and Newton's laws
Waves (sound, light) and simple machines	Chemical reactions and conservation of mass	Electricity, magnetism, and circuits
Basics of motion and forces	Acids, bases, and solutions	Energy transformations (e.g., kinetic ↔ thermal)

Earth & Space Science (ESS)

6th Grade	7th Grade	8th Grade
Water cycle, weather, and climate	Earth's geosphere, hydrosphere, and resources	Astronomy (solar system, galaxies, gravity)
Structure of Earth's atmosphere	Human impacts on ecosystems and sustainability	Earth's history (fossils, geologic time)
Natural disasters (e.g., hurricanes, droughts)	Plate tectonics and rock cycle	Climate change and Earth's systems interactions

Engineering & Technology (ETS)

6th Grade	7th Grade	8th Grade
Engineering design process (prototype testing)	Design solutions for human body systems	Advanced engineering challenges (e.g., robotics, energy efficiency)
Real-world problems (e.g., water filtration)	Optimizing material use for chemical processes	Analyzing data to improve technologies
Evaluating environmental solutions	Mitigating human impacts on Earth's systems	Space exploration technologies

Key Progressions:

- **Life Science**: Expands from ecosystems (6th) to cellular biology (7th) and genetics/evolution (8th).
- **Physical Science**: Builds from energy basics (6th) to chemistry (7th) and advanced physics (8th).
- **Earth/Space**: Progresses from weather (6th) to Earth's systems (7th) and astronomy (8th).
- **Engineering**: Increases in complexity, integrating domain-specific knowledge each year.

This alignment reflects the scaffolding of concepts across middle school grades in Tennessee, ensuring a cohesive science education framework. For detailed standards, refer to the Tennessee Department of Education.

Here's an alignment of 6th, 7th, and 8th grade math standards based on the Tennessee State Standards, structured by domain to show progression across grades:

1. Ratios & Proportional Relationships

- **6th Grade**
  - Understand ratios, unit rates, and equivalent ratios.
  - Solve problems involving percentages and measurement unit conversions.
  - Use ratio reasoning to analyze relationships (e.g., speed, density).
- **7th Grade**
  - Compute unit rates with fractions.
  - Solve multi-step ratio, percent, and interest problems (tax, discounts, markups).
  - Represent proportional relationships with equations and graphs.
- **8th Grade**
  - Connect proportional relationships to linear equations.
  - Interpret slope as a rate of change.
  - Analyze functions modeling proportional and non-proportional relationships.

2. The Number System

- **6th Grade**
  - Divide fractions and multi-digit numbers fluently.
  - Extend number lines to negative numbers; find absolute value.
  - Solve real-world problems with coordinates in all quadrants.
- **7th Grade**
  - Add, subtract, multiply, and divide rational numbers (including negatives).
  - Apply properties of operations to solve problems with rational numbers.
- **8th Grade**
  - Classify numbers as rational or irrational.
  - Use exponents, roots, and scientific notation.
  - Estimate irrational numbers (e.g., $\sqrt{2} \approx 1.414$).

3. Expressions & Equations

- **6th Grade**
  - Write and evaluate algebraic expressions.
  - Solve one-variable equations and inequalities.
  - Represent dependent/independent variables in real-world contexts.

- **7th Grade**
  - Expand, factor, and simplify linear expressions.
  - Solve multi-step equations and inequalities with rational numbers.
  - Represent solutions to inequalities on number lines.
- **8th Grade**
  - Solve linear equations and systems of equations.
  - Apply laws of exponents and scientific notation.
  - Analyze solutions for one-variable equations (e.g., no solution, infinite solutions).

4. Geometry

- **6th Grade**
  - Calculate area, surface area, and volume of triangles, quadrilaterals, and rectangular prisms.
  - Plot polygons on coordinate planes.
- **7th Grade**
  - Solve problems involving scale drawings and geometric constructions.
  - Explore angle relationships (complementary, supplementary, vertical).
  - Calculate area and circumference of circles.
- **8th Grade**
  - Perform and describe translations, rotations, reflections, and dilations.
  - Apply the Pythagorean Theorem.
  - Solve problems involving volume of cones, cylinders, and spheres.
  - Analyze congruence and similarity using transformations.

5. Statistics & Probability

- **6th Grade**
  - Recognize statistical variability.

    - Summarize data using measures of center (mean, median) and spread (range, IQR).
    - Display data in dot plots, histograms, and box plots.
- **7th Grade**
    - Draw inferences from random samples.
    - Compare populations using measures of center/variability.
    - Calculate probabilities of simple and compound events.
- **8th Grade**
    - Construct and interpret scatter plots for bivariate data.
    - Use lines of best fit to model relationships.
    - Analyze patterns in two-way tables.

6. Functions (8th Grade Focus)

- **8th Grade**
    - Define, evaluate, and compare functions.
    - Interpret linear functions as rate of change.
    - Model relationships with linear and nonlinear functions.