STEM 6

The Technology and Engineering Education Department

Course Number: 6651

Course Level: Middle School

Grade: 6

Time/Credit: 22 Periods /.25 Credit

Development Date: 2025 - 2026

School Board Approval:

Central Bucks School District
20 Welden Drive
Doylestown, PA 18901

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Central Bucks School District
Teaching and Learning Principles

1. **Learning is Active and Experiential-** Students learn by doing, making, and reflecting. Hands-on, minds-on, project-based learning connects ideas to real contexts.
2. **Design and Problem-Solving Thinking Drives Learning-** Design challenges build creativity, critical thinking, and persistence. Students apply the engineering design and problem-solving process: identify, design, build, test, improve.
3. **Learning is Integrated (STEAM Approach)**- Real-world problems cross disciplines to blend science, technology, engineering, art, and math with an emphasis on TECHNOLOGY and ENGINEERING.
4. **Creativity and Innovation are Important**- Students are creators, inventors, and problem solvers. Emphasis is on idea generation, iteration, and supervised risk-taking.
5. **Learning is Collaborative and Social**- Teamwork mirrors real engineering and design practice. Students share ideas, give feedback, and build together.
6. **Technological Literacy is achieved through tools** - Students develop technological literacy through authentic use and creation. Tools include traditional hand tools and human operated machines and modern tools including CAD, coding, robotics, 3D printing, CNC, and laser systems.
7. **Learning is Inclusive and Equitable-** All learners deserve meaningful access to STEAM experiences. Curriculum reflects diverse cultures, needs, and perspectives.
8. **Assessment is Authentic and Reflective**- Teachers will evaluate process, creativity, and growth—not just outcomes. Portfolios, journals, and exhibitions measure understanding.
9. **Environments are Safe, Flexible, and Future-Focused-** Space and culture support exploration and innovation. Safe, organized, and adaptable fabrication shops and prototyping labs foster creative problem-solving.
10. **Reflection and Lifelong Learning are Essential**- Students learn through reflection and iteration. Reflection documents and portfolios reinforce growth.

Documents Considered:

1. Experiential and Constructivist Learning
   - Bruner, J. (1966). *Toward a Theory of Instruction.* Harvard University Press.
   - Kolb, D. A. (1984). *Experiential Learning: Experience as the Source of Learning and Development.* Prentice-Hall.
2. Design Thinking and Engineering Design
   - IDEO. (2012). *Design Thinking for Educators Toolkit.* IDEO.
   - National Academy of Engineering. (2020). *Standards for Technological and Engineering Literacy: The Role of Technology and Engineering in STEM Education (STEL).* Washington, DC: National Academies Press.
3. Integrated STEAM Learning
   - Honey, M., Pearson, G., & Schweingruber, H. (Eds.). (2014). *STEM Integration in K–12 Education: Status, Prospects, and an Agenda for Research.* National Academies Press.
   - Yakman, G. (2008). *STEAM Education: An Overview of Creating a Model of Integrative Education.* In *PATT-19 Conference: Research on Technology Education.*
4. Creativity and Innovation in Education
   - Robinson, K. (2011). *Out of Our Minds: Learning to Be Creative.* Capstone Publishing.
   - International Technology and Engineering Educators Association (ITEEA). (2020). *Standards for Technological and Engineering Literacy: Defining the Role of Technology and Engineering in STEM Education.*
5. Collaborative and Social Learning
   - Johnson, D. W., & Johnson, R. T. (2009). *An Educational Psychology Success Story: Social Interdependence Theory and Cooperative Learning. Educational Researcher*, 38(5), 365–379.
   - Vygotsky, L. S. (1978). *Mind in Society: The Development of Higher Psychological Processes.* Harvard University Press.

6. Technological Literacy
- Mishra, P., & Koehler, M. J. (2006). *Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge. Teachers College Record*, 108(6), 1017–1054.
- ITEEA (2020). *Standards for Technological and Engineering Literacy (STEL).*

7. Equity and Cultural Relevance in STEAM
- Banks, J. A. (2008). *An Introduction to Multicultural Education.* Pearson Education.
- Ladson-Billings, G. (1995). *Toward a Theory of Culturally Relevant Pedagogy. American Educational Research Journal*, 32(3), 465–491.

8. Assessment for Learning
- Black, P., & Wiliam, D. (1998). *Assessment and Classroom Learning. Assessment in Education: Principles, Policy & Practice*, 5(1), 7–74.
- Wiggins, G. (1998). *Educative Assessment: Designing Assessments to Inform and Improve Student Performance.* Jossey-Bass.

9. Learning Environments and Pedagogy
- Dewey, J. (1938). *Experience and Education.* Macmillan.
- Marzano, R. J. (2007). *The Art and Science of Teaching: A Comprehensive Framework for Effective Instruction.* ASCD.

10. Reflection and Lifelong Learning
- Hattie, J. (2012). *Visible Learning for Teachers: Maximizing Impact on Learning.* Routledge.
- Schön, D. A. (1983). *The Reflective Practitioner: How Professionals Think in Action.* Basic Books.

Central Bucks School District
Enduring Understandings

Students will understand that:

- the various systems of measurement and scale impact a drawing.
- measuring and technical drawing integrate mathematical concepts and scientific principles, illustrating their practical applications in real-world problem-solving and design.
- basic drafting equipment aids in the development of a final drawing.
- there are specific characteristics that constitute a technical drawing.
- the engineering design process is a structured framework that guides problem-solving and innovation, emphasizing the importance of following systematic steps to achieve effective solutions.
- the engineering design process is a structured framework that guides problem-solving and innovation, emphasizing the importance of following systematic steps to achieve effective solutions.
- the world continues to evolve from the engineering design process.
- the engineering design process applies to a wide range of fields and challenges, demonstrating its relevance in addressing real-world issues.
- effective feedback of ideas, processes, and solutions is vital in engineering, as it facilitates collaboration, stakeholder engagement, and the successful implementation of designs.
- using tools and materials responsibly fosters precision, patience, and a deeper respect for craftsmanship and safety.
- functional design blends creativity, engineering, and problem-solving to meet both practical and aesthetic goals.
- how math, science, and art intersect in woodworking through measuring, planning, constructing, and solving real-world design challenges.
- engineers use digital design tools to transform ideas into precise, customized physical creations, enhancing creativity, problem-solving, and innovation in engineering.
- robotics and coding are critical in the modern economy.
- humans are needed in the creation of robotics.
- coding requires a certain sequence and language to automate.

Central Bucks School District
Essential Questions

- Why is precision in measurement important in both everyday life and professional fields?
- How to appropriately utilize the proper tool to measure accurately to 1/16th of an inch?
- What are the key components of a technical drawing, and how do they communicate design ideas?
- What tools are most effective for creating precise technical drawings, and why?
- How has technology changed the way we measure and create technical drawings?
- Why is it important to follow a systematic approach when solving engineering problems?
- What are the key stages of the engineering design process, and how do they interconnect?
- How do engineers use the engineering design process to solve problems?
- How do different woodworking tools work, and how can you use them safely?
- What are the steps in the building process, and which ones require the most precision?
- How can you sketch a design that's both functional and creative?
- How can you personalize your project while keeping it functional?
- How can we use technology to transform our ideas into physical creations?
- How do digital tools expand or limit what we can create in manufacturing and woodworking?
- How do makers use technology to solve real-world problems?
- What is a robot, and how does it help solve real-word problems?
- What does it mean to innovate with robotics and coding?
- Where is the future of robotics and coding in technology and industry?

Central Bucks School District – Course of Study Overview
STEM 6

Desired Results

Course Description: Students will begin their Science, Technology, ENGINEERING and Mathematics (STEM) middle school experience by continuing their QUEST elementary education as they are reintroduced to the foundations of STEM through minds on, hands-on project-based learning. Students will interact with small woodworking machines and tools, drawing tools, basic physical coding in robotics, computer aided design (CAD), 2D subtractive manufacturing machines such as a laser engraver, vinyl cutter and 3D printing additive technology. Projects may include a technical drawing, a small woodshop project, robotics with microcontrollers and other design and prototype-based activities. Emphasis is placed on individual and teamwork by applying the engineering design and problem-solving process to fun and engaging real world challenges. STEM 6 lays the foundation to develop technological literacy within the STEM framework.

Prerequisite: None

Committee Members**: Kerri Brumbaugh, Bruce Good, Chris Dallas, Jon Taylor**

Acceptable Evidence.

Common Summative Assessment 1: Common STEM Engineering Project
Common Summative Assessment 2: Common STEM Engineering Process

Course Grading: 90 Percent Summative, 10 Percent Formative

STEM 6 – Pacing Guide

Content	Days
Unit 1 – Developing STEM Design Skills: Measuring and Technical Drawing	**7**
Intro to STEM	.5
Measuring	2.5
Technical Drawing	4
Unit 2 – STEM Engineering Design Process	**4**
Introduction	.5
Safety	.5
Design Challenge	1
Production, Test, Reflect	2
Unit 3 – Mission Manufacturing	**8**
Introduction	1
Safety	1
Read a Design/Design a Part	3
Construct/Test	3
Unit 4 -Intro. To Robotics	**3**
Introduction	.25
Safety	.25
Physical Coding Instruction and Application	.25
Coding Challenge	1.25
Total	22

Required Texts and Software- VEX, Crumble kit, technical drawing supplies, woodshop, prototyping materials, laser cutter, vinyl cutter, 3d printer

Central Bucks School District – Course of Study – STEM 6
Unit 1 – Precision in Design: Measuring and Technical Drawing

Desired Results:

Essential Questions:

- Why is precision in measurement important in both everyday life and professional fields?
- How to appropriately utilize the proper tool to measure accurately to 1/16th of an inch?
- What are the key components of a technical drawing, and how do they communicate design ideas?
- What tools are most effective for creating precise technical drawings, and why?
- How has technology changed the way we measure and create technical drawings?

Enduring Understandings:
Students will understand that…

- the various systems of measurement and scale impact a drawing.
- measuring and technical drawing integrate mathematical concepts and scientific principles, illustrating their practical applications in real-world problem-solving and design.
- basic drafting equipment aids in the development of a final drawing.
- there are specific characteristics that constitute a technical drawing.

Knowledge:
Students will know…

- measurement to the nearest 1/16th of an inch
- the characteristics and procedures of drafting
- how to navigate a Computer Aided Drawing Program

Skills:

Students will be able to…

- utilize measurement and drafting tools in the accurate creation of a drawing
- how to apply hand drawing skills to create Computer Aided Designs

Standards:
<u>Priority:</u>
PDE STEELS:
3.5.6-8.J Use tools, materials, and machines to safely diagnose, adjust, and repair systems.
3.5.6-8.Q Apply a technology and engineering design thinking process.
3.5.6-8.JJ Apply informed problem-solving strategies to the improvement of existing devices or processes or the development of new approaches.
3.5.6-8.KK Explain how technology and engineering are closely linked to creativity, which can result in both intended and unintended innovations.
3.5.6-8.V Refine design solutions to address criteria and constraints.

ITEEA Standards for Technological Literacy:
-Make two-dimensional and three-dimensional representations of the designed solution.
-Design involves a set of steps, which can be performed in different sequences and repeated as needed.
-The use of symbols, measurements, and drawings promotes clear communication by providing a common language to express ideas.

<u>Supporting</u>:
Math Standards:

-Attend to precision.
-Describing the nature of the attribute under investigation, including how it was measured and its units of measurement.
PDE Arts and Humanities:
9.1.8.A Know and use the elements and principles of each art form to create works in the arts and humanities.

Acceptable Evidence:

Performance Tasks –
Acceptable evidence of learning other than Performance Tasks:
Formative Assessment

- Measuring Practice
- Technical Notes
- Sketching

Summative Assessment

- Measuring Test
- Technical Drawing Portfolio
- Computer Aided Drawing Portfolio

Suggested Learning Experiences and Instruction

Learning Experiences:

- Practice reading a ruler
- Utilize a ruler and measure lines
- Display knowledge of measuring on a summative assessment
- Use drafting tools to draw both orthographic and isometric drawings

Instructional Strategies:

- Direct instruction: measuring and reading a ruler to a 1/16th of an inch
- Reviewing drafting tools, their purpose and how to use
- Teacher demonstration of drafting a technical drawing
- Deliberate Practice
- Peer teaching model
- Self-check and evaluation

Differentiation/Intervention/Enrichment Options:

- **Differentiated/Intervention:**
    - Adapted Measuring Tools
    - Measuring Video Tutorial
    - Teacher Intervention during I&E
    - Technical Drawing Video Tutorial
    - Peer Tutoring
- **Enrichment:**
    - Sketch a Woodshop Tool
    - Explore Computer Aided Drafting and design a choice object

<u>For Language Development</u>:

- Students will understand measuring terms and verbiage used in the engineering world.

Central Bucks School District – Course of Study – STEM 6
Unit 2 – Engineering Design Process

Desired Results:

Essential Questions:
- Why is it important to follow a systematic approach when solving engineering problems?
- What are the key stages of the engineering design process, and how do they interconnect?
- How do engineers use the engineering design process to solve problems?

Enduring Understandings:
Students will understand that…
- the engineering design process is a structured framework that guides problem-solving and innovation, emphasizing the importance of following systematic steps to achieve effective solutions.
- the world continues to evolve from the engineering design process.
- the engineering design process applies to a wide range of fields and challenges, demonstrating its relevance in addressing real-world issues.
- effective feedback of ideas, processes, and solutions is vital in engineering, as it facilitates collaboration, stakeholder engagement, and the successful implementation of designs.

Knowledge:
Students will know…
- the steps of the Engineering Design Process

Skills:
Students will be able to…
- utilize the steps of the Engineering Design Process to solve a problem.
- apply knowledge and skills from Unit 1 to effectively measure and draw design solutions for design challenges.
- design, build, test and test a solution to a design challenge.
- reflect on their solution discussing problems solved, knowledge gained, and improvements you would have made.

Standards:
Priority:
PDE STEELS:
3.5.6-8.Q Apply a technology and engineering design thinking process.
3.5.6-8.R Develop innovative products and systems that solve problems and extend capabilities based on individual or collective needs and wants.
3.5.6-8.JJ Apply informed problem-solving strategies to the improvement of existing devices or processes or the development of new approaches.
3.5.6-8.KK Explain how technology and engineering are closely linked to creativity, which can result in both intended and unintended innovations.
3.5.6-8.V Refine design solutions to address criteria and constraints.
3.5.6-8LL Compare how different technologies involve different sets of processes.

ITEEA Standards for Technological Literacy:
-Make two-dimensional and three-dimensional representations of the designed solution.

-Design involves a set of steps, which can be performed in different sequences and repeated as needed.
-The use of symbols, measurements, and drawings promotes clear communication by providing a common language to express ideas.
- Manufacturing systems use mechanical processes that change the form of materials through the processes of separating, forming, combining, and conditioning.
- The design of a message is influenced by such factors as the intended audience, medium, purpose, and nature of the message.

Supporting:
Core Math Standards:
-Attend to precision.
-Describing the nature of the attribute under investigation, including how it was measured and its units of measurement.

Core Art Standards
-Combine concepts collaboratively to generate innovative ideas for creating art.

Acceptable Evidence:

Performance Tasks –
Acceptable evidence of learning other than Performance Tasks:
Formative Assessment

- Technical Notes
- Research and Brainstorming
- Design Sketches

Summative Assessment

- Final Design Sketches
- Project Rubric

Suggested Learning Experiences and Instruction

Learning Experiences:

- Review the steps of the Engineering Design Process
- Use the steps of the Engineering Design Process to solve an Engineering Challenge

Instructional Strategies:

- Direct instruction
- Video overview of Design Process
- Teacher Demonstration
- Problem-Solving and Critical Thinking
- Self-check and evaluation

Differentiation/Intervention/Enrichment Options:

- **Differentiated/Intervention:**
    - Research vs Design option for student exploration
    - Teacher Intervention during I&E
- **Enrichment:**
    - Small design and problem-solving challenges
    - Explore a type of engineer and the problems they solve

For Language Development:

- Students will utilize technical writing techniques to understand and reflect upon the process taken and completed for the project through a portfolio.
- Students will experience group work and enhance their communication skills.

Central Bucks School District – Course of Study – STEM 6
Unit 3- Mission: Manufacturing

Desired Results:

Essential Questions:
- How do different woodworking tools work, and how can you use them safely?
- What are the steps in the building process, and which ones require the most precision?
- How can you sketch a design that's both functional and creative?
- How can you personalize your project while keeping it functional?

Enduring Understandings:
Students will understand that…
- Using tools and materials responsibly fosters precision, patience, and a deeper respect for craftsmanship and safety.
- Functional design blends creativity, engineering, and problem-solving to meet both practical and aesthetic goals.
- How math, science, and art intersect in woodworking through measuring, planning, constructing, and solving real-world design challenges.

Knowledge:
Students will know…
- The process of taking raw material to create a project.
- How to solve a design challenge in a woodworking project.

Skills:
Students will be able to…
- safely use woodworking tools and equipment.
- utilize their measuring and drawing skills to aid in the design and creation of a project.

Standards:
<u>Priority:</u>
PDE STEELS:
3.5.6-8.Q Apply a technology and engineering design thinking process.
3.5.6-8.R Develop innovative products and systems that solve problems and extend capabilities based on individual or collective needs and wants.
3.5.6-8.JJ Apply informed problem-solving strategies to the improvement of existing devices or processes or the development of new approaches.
3.5.6-8.KK Explain how technology and engineering are closely linked to creativity, which can result in both intended and unintended innovations.
3.5.6-8.V Refine design solutions to address criteria and constraints.
3.5.6-8LL Compare how different technologies involve different sets of processes.

ITEEA Standards for Technological Literacy:
-Make two-dimensional and three-dimensional representations of the designed solution.
-Design involves a set of steps, which can be performed in different sequences and repeated as needed.
-The use of symbols, measurements, and drawings promotes clear communication by providing a common language to express ideas.
- Manufacturing systems use mechanical processes that change the form of materials through the processes of separating, forming, combining, and conditioning.

- The design of a message is influenced by such factors as the intended audience, medium, purpose, and nature of the message.

Supporting:
Common Core Math Standards:
-Attend to precision.
-Describing the nature of the attribute under investigation, including how it was measured and its units of measurement.

Acceptable Evidence:

Performance Tasks –
Acceptable evidence of learning other than Performance Tasks:
Formative Assessment
- Technical Notes
- Design Sketches

Summative Assessment
- Safety Test
- Project Rubric

Suggested Learning Experiences and Instruction

Learning Experiences:
- Review machine use and safety
- Show proficiency in use of machines and tools
- Use woodworking machines and tools to create a project

Instructional Strategies:
- Direct instruction
- Teacher Demonstration
- Project-based learning
- Problem-Solving and Critical Thinking
- Guided Reflection

Differentiation/Intervention/Enrichment Options:
- **Differentiated/Intervention:**
  - Use templates or jigs for students who need more structure.
  - Provide checklists, sentence starters for reflection, and graphic organizers for planning.
- **Enrichment:**
  - Invite students to create alternate versions of the project with constraints
  - Pose real-world problems like "How would you mass-produce this board efficiently?"

For Language Development:
- Students will utilize technical writing techniques to understand and reflect upon the process taken and completed for the project through a portfolio.

Central Bucks School District – Course of Study –STEM 6
Unit 4 – Introduction to Robotics

Desired Results:

Essential Questions:

- What is a robot, and how does it help solve real-word problems?
- What does it mean to innovate with robotics and coding?
- Where is the future of robotics and coding in technology and industry?

Enduring Understandings:
Students will understand that…

- Robotics and coding are critical in the modern economy
- Humans are needed in the creation of robotics
- Coding requires a certain sequence and language to automate

Knowledge:
Students will know…

- Programming vocabulary
- Program sequencing
- How to debug, troubleshoot and problem solve

Skills:

Students will be able to…

- Understand automation, robotics and coding
- Apply critical thinking and problem solving

Standards:

Priority:

Systems & Control

- 3.5.6–8.K — Use devices to control technological systems.
- 3.5.6–8.EE — Differentiate between inputs, processes, outputs, and feedback in technological systems.
- 3.5.6–8.FF — Demonstrate how systems thinking involves considering relationships between every part and the environment.

Engineering Design & Problem Solving

- 3.5.6–8.Q — Apply a technology and engineering design thinking process.
- 3.5.6–8.R — Develop innovative products and systems that solve problems and extend capabilities.
- 3.5.6–8.V — Refine design solutions to address criteria and constraints.
- 3.5.6–8.JJ — Apply informed problem-solving strategies to improve devices or processes.

Tools, Materials, Mechanisms

- 3.5.6–8.J — Use tools, materials, and machines to safely diagnose, adjust, and repair systems.

Supporting:

Technology in Society

- 3.5.6–8.F — Analyze technologies that have changed how people think, interact, live, and communicate.
- 3.5.6–8.CC — Consider historical factors that contributed to technological development.

Acceptable Evidence:

Performance Tasks – Structure- Learn about the parts of the robot, Motion- Drive the Robot, Control- Use block coding to control the robot

Acceptable evidence of learning other than Performance Tasks:

Formative Assessment

- Research Activity
- Self/partner-checklist

Summative Assessment

- Project Rubric

Suggested Learning Experiences and Instruction

Learning Experiences:

- Explore automation, robotics, and coding
- Display knowledge of coding

Instructional Strategies:

- Direct instruction
- Teacher Demonstration
- Problem-Solving and Critical Thinking
- Self-check and evaluation

Differentiation/Intervention/Enrichment Options:

- **Differentiated/Intervention:**
    - Tiered Lessons: providing varying levels of complexity
    - Scaffolded Instruction
- **Enrichment:**
    - Choice-Based: Students explore interests

For Language Development:

- Students will utilize technical writing techniques to explore different areas of automation, robotics, and coding.