

Unit 1: Design Thinking

Content Area: **Template**
Course(s):
Time Period: **Full Year**
Length: **Full Year**
Status: **Published**

UNIT RATIONALE

Unit 1 focuses on introducing students to the principles of design thinking and engineering, while integrating key concepts from computer science and design thinking standards. Through hands-on activities and design challenges, students will develop their problem-solving skills, creativity, and critical thinking abilities. They will learn to identify and define problems, empathize with users, generate innovative ideas, and prototype and test their solutions. This unit aims to foster a growth mindset, collaboration, computational thinking, and the application of design thinking in various contexts.

ESSENTIAL QUESTIONS

Subtopic 1.1: Understanding Design Thinking

1. What is design thinking and why is it important?
2. How does design thinking apply to real-world problems?
3. What are the key steps and principles of the design thinking process?
4. How can design thinking be used to foster creativity and innovation?

Subtopic 1.2: Empathy and User-Centered Design

1. Why is empathy important in the design process?
2. How can we understand the needs and perspectives of users?
3. What are the key methods and tools for practicing empathy in design?
4. How does user-centered design contribute to successful design solutions?

Subtopic 1.3: Ideation and Concept Development

1. How can we generate creative ideas for design solutions?
2. What techniques can we use to expand and refine our design concepts?
3. How do we select and prioritize design ideas for further development?
4. What role does prototyping play in the concept development phase?

Subtopic 1.4: Testing, Feedback, and Iteration

1. How can we effectively test and evaluate our design solutions?
2. What role does feedback play in improving design solutions?
3. How do we incorporate feedback to iterate and refine our designs?
4. Why is continuous iteration important in the design process?

STANDARDS

NEW JERSEY STUDENT LEARNING STANDARDS: CONTENT AREA

New Jersey (NJSLS) - Grade 7 - Mathematics (2020)

7.RP.A.1

Compute unit rates associated with ratios of fractions, including ratios of lengths, areas and other quantities measured in like or different units. For example, if a person walks $\frac{1}{2}$ mile in each $\frac{1}{4}$ hour, compute the unit rate as the complex fraction $\frac{1/2}{1/4}$ miles per hour, equivalently 2 miles per hour.

7.RP.A.2

Recognize and represent proportional relationships between quantities.

7.RP.A.2.a

Decide whether two quantities are in a proportional relationship, e.g., by testing for equivalent ratios in a table or graphing on a coordinate plane and observing whether the graph is a straight line through the origin.

7.RP.A.2.b

Identify the constant of proportionality (unit rate) in tables, graphs, equations, diagrams, and verbal descriptions of proportional relationships.

7.RP.A.2.c

Represent proportional relationships by equations. For example, if total cost t is proportional to the number n of items purchased at a constant price p , the relationship between the total cost and the number of items can be expressed as $t = pn$.

7.RP.A.2.d

Explain what a point (x, y) on the graph of a proportional relationship means in terms of the situation, with special attention to the points $(0, 0)$ and $(1, r)$ where r is the unit rate.

7.RP.A.3

Use proportional relationships to solve multistep ratio and percent problems. Examples: simple interest, tax, markups and markdowns, gratuities and commissions, fees, percent increase and decrease, percent error.

7.G.A

Draw, construct, and describe geometrical figures and describe the relationships between them.

7.G.A.1

Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale.

7.G.A.2

Draw (with technology, with ruler and protractor, as well as freehand) geometric shapes with given conditions. Focus on constructing triangles from three measures of angles or sides, noticing when the conditions determine a unique triangle, more than one triangle, or no triangle.

New Jersey (NJSLS) - Grades 6-8 - Computer Science and Design Thinking (2020)

8.2.8.ED.2:

Identify the steps in the design process that could be used to solve a problem.

8.2.8.ED.3:

Develop a proposal for a solution to a real-world problem that includes a model (e.g., physical prototype, graphical/technical sketch).

8.2.8.ED.4:

Investigate a malfunctioning system, identify its impact, and explain the step-by-step process used to troubleshoot, evaluate, and test options to repair the product in a collaborative team.

8.2.8.ED.7:

Design a product to address a real-world problem and document the iterative design process, including decisions made as a result of specific constraints and trade-offs (e.g., annotated sketches).

[addStandards](#)

comment

help

MA.7.RP.A.1	Compute unit rates associated with ratios of fractions, including ratios of lengths, areas and other quantities measured in like or different units.
MA.7.RP.A.2	Recognize and represent proportional relationships between quantities.
MA.7.RP.A.2a	Decide whether two quantities are in a proportional relationship, e.g., by testing for equivalent ratios in a table or graphing on a coordinate plane and observing whether the graph is a straight line through the origin.
MA.7.RP.A.2b	Identify the constant of proportionality (unit rate) in tables, graphs, equations, diagrams, and verbal descriptions of proportional relationships.
MA.7.RP.A.2c	Represent proportional relationships by equations.
MA.7.RP.A.2d	Explain what a point (x, y) on the graph of a proportional relationship means in terms of the situation, with special attention to the points $(0, 0)$ and $(1, r)$ where r is the unit rate.
MA.7.RP.A.3	Use proportional relationships to solve multistep ratio and percent problems.
MA.7.G.A	Draw, construct, and describe geometrical figures and describe the relationships between them.
MA.7.G.A.1	Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale.
MA.7.G.A.2	Draw (with technology, with ruler and protractor, as well as freehand) geometric shapes with given conditions. Focus on constructing triangles from three measures of angles or sides, noticing when the conditions determine a unique triangle, more than one triangle, or no triangle.
CS.6-8.8.2.8.ED.2	Identify the steps in the design process that could be used to solve a problem.
CS.6-8.8.2.8.ED.3	Develop a proposal for a solution to a real-world problem that includes a model (e.g., physical prototype, graphical/technical sketch).
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CS.6-8.8.2.8.ED.7	Design a product to address a real-world problem and document the iterative design process, including decisions made as a result of specific constraints and trade-offs (e.g., annotated sketches).

NEW JERSEY STUDENT LEARNING STANDARDS: CAREER READINESS, LIFE LITERACIES AND KEY SKILLS

MA.7.RP.A.2	Recognize and represent proportional relationships between quantities.
CS.6-8.8.2.8.ED.2	Identify the steps in the design process that could be used to solve a problem.
CS.6-8.8.2.8.ED.3	Develop a proposal for a solution to a real-world problem that includes a model (e.g., physical prototype, graphical/technical sketch).
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CS.6-8.8.2.8.ED.7	Design a product to address a real-world problem and document the iterative design process, including decisions made as a result of specific constraints and trade-offs (e.g., annotated sketches).

NEW JERSEY STUDENT LEARNING STANDARDS: COMPUTER SCIENCE AND DESIGN THINKING

CS.6-8.8.1.8.CS.1	Recommend improvements to computing devices in order to improve the ways users interact with the devices.
CS.6-8.8.1.8.DA.1	Organize and transform data collected using computational tools to make it usable for a specific purpose.
CS.6-8.8.1.8.DA.2	Explain the difference between how the computer stores data as bits and how the data is displayed.
CS.6-8.8.1.8.DA.3	Identify the appropriate tool to access data based on its file format.
CS.6-8.8.1.8.DA.4	Transform data to remove errors and improve the accuracy of the data for analysis.
CS.6-8.8.1.8.IC.2	Describe issues of bias and accessibility in the design of existing technologies.

PRE-ASSESSMENTS

1. Design Thinking Reflection: Ask students to write a brief reflection on their understanding of design thinking. Encourage them to define design thinking and provide examples of its application in everyday life or specific contexts.
2. Problem Identification: Present students with a real-world problem or challenge and ask them to brainstorm possible solutions or approaches. This will help assess their initial problem-solving skills and their ability to think creatively.
3. Design Process Mapping: Provide students with a visual representation of the design thinking process, such as a flowchart or diagram. Ask them to label each stage and briefly describe what happens in each step. This will gauge their familiarity with the design thinking framework.
4. Design Analysis: Show students different products or objects and ask them to evaluate their design from the perspective of the user and the producer. Prompt them to identify strengths and weaknesses, as well as possible improvements or modifications.
5. Collaboration Skills Assessment: Engage students in a short group activity that requires collaboration and

teamwork. Observe their ability to communicate, listen to others' ideas, contribute effectively, and work together to solve a problem.

[Virtual Scavenger Hunt 2022](#)

INSTRUCTIONAL PLAN

MODULE 1

Unit 1: Introduction to Design Thinking

Subtopic 1.1: Understanding Design Thinking

Subtopic 1.2: Empathy and User-Centered Design

Subtopic 1.3: Ideation and Concept Development

Subtopic 1.4: Testing, Feedback, and Iteration

Major Projects:

Topographical Map for integer understanding

Paper Cutting craft with lines and angles

Floor Plan and Elevation

Essential Questions:

1. What is design thinking and how can it be applied to solve real-world problems?
2. How can empathy and user analysis contribute to the design process?
3. What are the key steps and strategies involved in generating innovative ideas?
4. How can prototyping and testing help improve and refine design solutions?

Learning Intentions:

By the end of this unit, students will be able to:

1. Understand the core principles and stages of the design thinking process.
2. Apply empathy and user analysis techniques to identify and define problems.
3. Generate and evaluate innovative ideas using brainstorming and other ideation strategies.
4. Create prototypes to represent and test their design solutions.
5. Collaborate effectively in teams to solve design challenges.
6. Apply computational thinking skills to analyze and solve design problems.

Learning Strategies:

1. Inquiry-Based Learning: Encourage students to explore and inquire about design problems, seeking information and multiple perspectives.
2. Hands-on Activities: Provide opportunities for students to engage in hands-on design challenges and projects to apply their learning.
3. Reflection and Discussion: Promote reflection and discussion on design choices, problem-solving strategies, and lessons learned.

4. Collaborative Learning: Encourage students to work in teams, sharing ideas, and collaborating on design solutions.
5. Feedback and Iteration: Emphasize the importance of feedback and iterative design processes, encouraging students to refine and improve their solutions.
6. Computational Thinking: Integrate computational thinking concepts, such as decomposition, pattern recognition, abstraction, and algorithmic thinking, in design challenges.

Success Criteria:

1. Demonstrated understanding of the design thinking process and its stages.
2. Effective application of empathy and user analysis techniques to identify and define design problems.
3. Generation of diverse and innovative ideas using appropriate ideation strategies.
4. Creation of prototypes that effectively represent and communicate design solutions.
5. Active participation and collaboration in team-based design challenges.
6. Integration of computational thinking concepts in problem-solving and design processes.

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Subtopic 1.1

Subtopic 1.1 - Understanding Design Thinking

Essential Questions:

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4. Creation of prototypes that effectively represent and communicate design solutions.

5. Active participation and collaboration in team-based design challenges.

6. Integration of computational thinking concepts in problem-solving and design processes.

Design Challenges:

Create a topographical map and describe how people and integers interact in the real world.

Redesign a school product to improve either functionality or aesthetics.

Create a functional piece of furniture with sustainable materials.

1. Design Challenge: Marble Run:

Task: Provide students with materials such as cardboard tubes, paper cups, tape, and marbles. Challenge them to design and build a functional marble run that meets specific criteria, such as including twists, turns, and obstacles. Students should ideate, prototype their designs, test them, and iterate based on the performance and feedback.

2. Reverse Engineering:

Task: Select a simple object, such as a stapler or a pencil sharpener, and ask students to reverse engineer it. Provide them with the object and tools such as rulers, calipers, and sketching materials. Students should carefully analyze the object's structure, mechanisms, and functionality, and then create detailed sketches or diagrams to document their findings.

3. Design Thinking Gallery Walk:

Task: Set up a gallery walk where students showcase their design thinking projects or prototypes. Each student or group can display their work along with a description of the problem they addressed, their design process, and the final solution. Encourage students to provide feedback and engage in discussions about different approaches and design choices.

4. Paper Prototyping:

Task: Choose a real-world problem or scenario, such as redesigning a classroom layout or improving a transportation system. Ask students to create paper prototypes that represent their proposed solutions. They can use paper, cardstock, markers, and other craft materials to design and present their ideas. Students should consider functionality, usability, and user experience.

5. Design Showcase:

Task: Organize a design showcase where students present their creative solutions to a specific problem. Allow them to choose any medium or format, such as posters, dioramas, models, or multimedia

presentations. Encourage students to articulate their design choices, explain the design process, and highlight the impact and benefits of their solutions.

Subtopic 1.2

Subtopic 1.2: Empathy and User-Centered Design

- Essential Questions:

1. Why is empathy important in the design process?
2. How can we understand the needs and perspectives of users?
3. What are the key methods and tools for practicing empathy in design?
4. How does user-centered design contribute to successful design solutions?

- Success Criteria:

- Students can explain the importance of empathy in the design process.
- Students understand and apply methods for gathering user insights.
- Students demonstrate the ability to consider user needs and perspectives in design solutions.
- Students can articulate the benefits of user-centered design.

- Learning Intentions:

1. Recognize the significance of empathy in design thinking.
2. Learn and practice methods for gathering user insights.
3. Apply user-centered design principles to create design solutions.
4. Communicate and justify design decisions based on user needs.

- Learning Strategies:

- Role-playing and perspective-taking exercises.
- Interviews and surveys to gather user insights.
- Analyzing case studies of successful user-centered design projects.
- Collaborative design challenges that prioritize user needs.

Design projects

Create a design a product that addresses a consumer need.

Interview consumers on products that they like and don't like and brainstorm an alternative

Create a podcast or YouTube video where they review a product.

1. User Persona Creation:

Task: Assign students the task of creating user personas for a specific product or service. Provide them with a brief description of the target audience, and ask them to develop detailed user personas that represent different user types and their needs, goals, and preferences. Students can use drawing, collage, or digital tools to bring their personas to life.

2. Empathy Interviews:

Task: Teach students the importance of empathy in understanding user needs. Ask them to conduct empathy

interviews with classmates or members of the school community. Provide guidance on interview techniques, active listening, and asking open-ended questions. Students should record and analyze the interview data to gain insights into user experiences and challenges.

3. Designing for Accessibility:

Task: Introduce students to the concept of inclusive design and accessibility. Assign them a specific task, such as designing a device or space that accommodates individuals with disabilities. Students should research and understand the unique needs of different users, brainstorm inclusive design solutions, and create prototypes using materials that simulate accessibility features.

4. User Feedback and Iteration:

Task: Assign students the task of obtaining feedback on a design or prototype. They can present their designs to classmates or teachers and gather feedback using questionnaires, surveys, or interviews. Students should analyze the feedback, identify areas for improvement, and make iterative changes to their designs based on the received input.

5. Constraints Challenge:

Task: Provide students with a set of constraints, such as limited materials, time, or budget, and challenge them to design a functional and innovative solution within those limitations. This activity encourages students to think creatively and problem-solve while considering realistic constraints. They can use any medium or materials available to build and present their designs.

Subtopic 1.3

Subtopic 1.3: Ideation and Concept Development

- Essential Questions:

1. How can we generate creative ideas for design solutions?
2. What techniques can we use to expand and refine our design concepts?
3. How do we select and prioritize design ideas for further development?
4. What role does prototyping play in the concept development phase?

- Success Criteria:

- Students can employ various ideation techniques to generate a range of design ideas.
- Students demonstrate the ability to refine and expand design concepts.
- Students can analyze and select promising ideas for further development.
- Students understand the purpose and benefits of prototyping in the design process.

- Learning Intentions:

1. Explore techniques for generating and expanding design ideas.
2. Refine and develop design concepts through iterative processes.
3. Evaluate and select promising design ideas for further development.
4. Understand the role of prototyping in the design thinking process.

- Learning Strategies:

- Brainstorming sessions with diverse perspectives.

- Sketching and visual thinking exercises.
- Group critiques and feedback sessions to refine ideas.
- Hands-on prototyping activities using low-fidelity materials.

Projects

Create a concept map

Work on a team - have everyone on your team play a single role of the design process - come up with an idea and see it from start to finish

Create a small model from wood using a renewable energy source (wind powered, solar, etc)

1. Brainstorming Session:

Task: Facilitate a brainstorming session where students generate a large number of ideas related to a given problem or challenge. Use techniques such as mind mapping, word association, or random stimuli to stimulate creative thinking. Encourage students to record their ideas visually or in writing, and emphasize the importance of quantity over quality during this ideation phase.

2. Mood Board Creation:

Task: Introduce students to the concept of mood boards as a tool for visualizing design concepts and aesthetics. Ask them to create mood boards for a specific design project, such as redesigning a classroom or creating a brand identity. Provide magazines, images, and art supplies for students to collect and arrange visual elements that reflect their desired design direction.

3. SCAMPER Technique:

Task: Introduce students to the SCAMPER technique (Substitute, Combine, Adapt, Modify, Put to another use, Eliminate, Reverse). Assign a design challenge and guide students through each SCAMPER step to generate new ideas and explore different design possibilities. Students should document their ideas and discuss their potential impact on the design problem.

4. Concept Sketching:

Task: Teach students the importance of sketching as a tool for visualizing design concepts. Provide drawing materials such as pencils, markers, and sketchbooks. Assign a design prompt, and ask students to sketch multiple concept ideas, focusing on quick ideation and exploring different design variations. Encourage them to annotate their sketches with brief explanations of the concepts.

5. Concept Pitch:

Task: Assign students the task of creating a concept pitch for their design ideas. They should prepare a short presentation to sell their concepts to a potential client or an audience. Encourage them to use visual aids, storytelling techniques, and persuasive communication skills to convey their design concepts effectively.

Subtopic 1.4

- Success Criteria:
 - Students can plan and conduct tests to evaluate design solutions.
 - Students actively seek and incorporate feedback to improve their designs.
 - Students demonstrate the ability to iterate and refine their design solutions.
 - Students understand the importance of continuous improvement in design.

- Learning Intentions:

1. Develop strategies for testing and evaluating design solutions.
2. Seek and utilize feedback to enhance design solutions.
3. Embrace iterative processes to refine and improve designs.
4. Cultivate a mindset of continuous improvement in design thinking.

- Learning Strategies:

- Creating testing plans and conducting experiments.
- Peer feedback and critique sessions.
- Analyzing and interpreting feedback to inform design iterations.
- Reflective journaling and documentation of design changes.

Design Challenges

1. Bridge Redesign Challenge:

Task: Provide students with materials such as craft sticks, popsicle sticks, cardboard, and tape. Challenge them to redesign a bridge using the given materials, focusing on improving its strength, stability, and aesthetic appeal. Students should ideate, create prototypes, test their designs, and iterate based on their findings.

2. Eco-Friendly Packaging Design:

Task: Ask students to design eco-friendly packaging for a specific product, such as a snack or a small item. They should consider materials that are sustainable, recyclable, and biodegradable. Students can create prototypes using materials like recycled paper, cardboard, and natural fibers. They should assess the functionality, environmental impact, and visual appeal of their designs.

3. Upcycled Art Installation:

Task: Challenge students to create an art installation using upcycled materials. Provide a variety of discarded objects such as bottles, cans, cardboard tubes, and fabric scraps. Students should brainstorm creative ways to transform these materials into an engaging and visually appealing art piece. Encourage them to experiment with different construction techniques and consider the message or theme behind their installation.

4. Sustainable Shelter Design:

Task: Ask students to design a sustainable shelter for a specific environment or climate. They should consider factors such as energy efficiency, use of renewable resources, and resilience to natural elements. Students can use materials like foam board, clay, fabric, and recyclable materials to construct a scaled model of their shelter. They should test the model's durability and functionality and make iterative improvements.

5. Community Garden Design:

Task: Have students design a community garden space that promotes sustainability, biodiversity, and community engagement. They should plan the layout, select appropriate plants, and incorporate eco-friendly features like rainwater harvesting or composting systems. Students can create a 2D blueprint or build a scaled model of their garden using materials such as clay, foam, or paper.

REFLECTIONS

INTERDISCIPLINARY CONNECTIONS: NEW JERSEY STUDENT LEARNING STANDARDS FOR ELA, SOCIAL STUDIES, SCIENCE AND/OR MATHEMATICS

1. Science Standards:

- 8.1.8.A.1: Apply scientific principles to design and conduct investigations.
- 8.1.8.B.1: Analyze and interpret data to make evidence-based conclusions.
- 8.1.8.C.1: Develop and use models to understand complex systems and relationships.
- 8.1.8.D.1: Use technology and computational thinking to solve problems.

2. Math Standards:

- 8.NS.A.1: Know that numbers that are not rational are called irrational.
- 8.NS.A.2: Use rational approximations of irrational numbers to compare the size of irrational numbers.
- 8.EE.A.2: Use square root and cube root symbols to represent solutions to equations.
- 8.G.A.5: Use informal arguments to establish facts about the angle sum and exterior angle of triangles.

3. Language Arts Standards:

- 8.RL.1: Cite the textual evidence that most strongly supports an analysis of what the text says explicitly.
- 8.RI.4: Determine the meaning of words and phrases as they are used in a text.
- 8.W.1: Write arguments to support claims with clear reasons and relevant evidence.
- 8.SL.1: Engage effectively in a range of collaborative discussions.

4. Social Studies Standards:

- 6.1.8.B.3: Analyze how individuals and groups have influenced economic, political, social, and cultural developments.
- 6.2.8.C.2: Explain the processes and consequences of conflict, cooperation, and interdependence among individuals, groups, and institutions.
- 6.2.8.C.3: Evaluate how technological advancements have shaped society and impacted various groups.