STEM Education
Lecture 9

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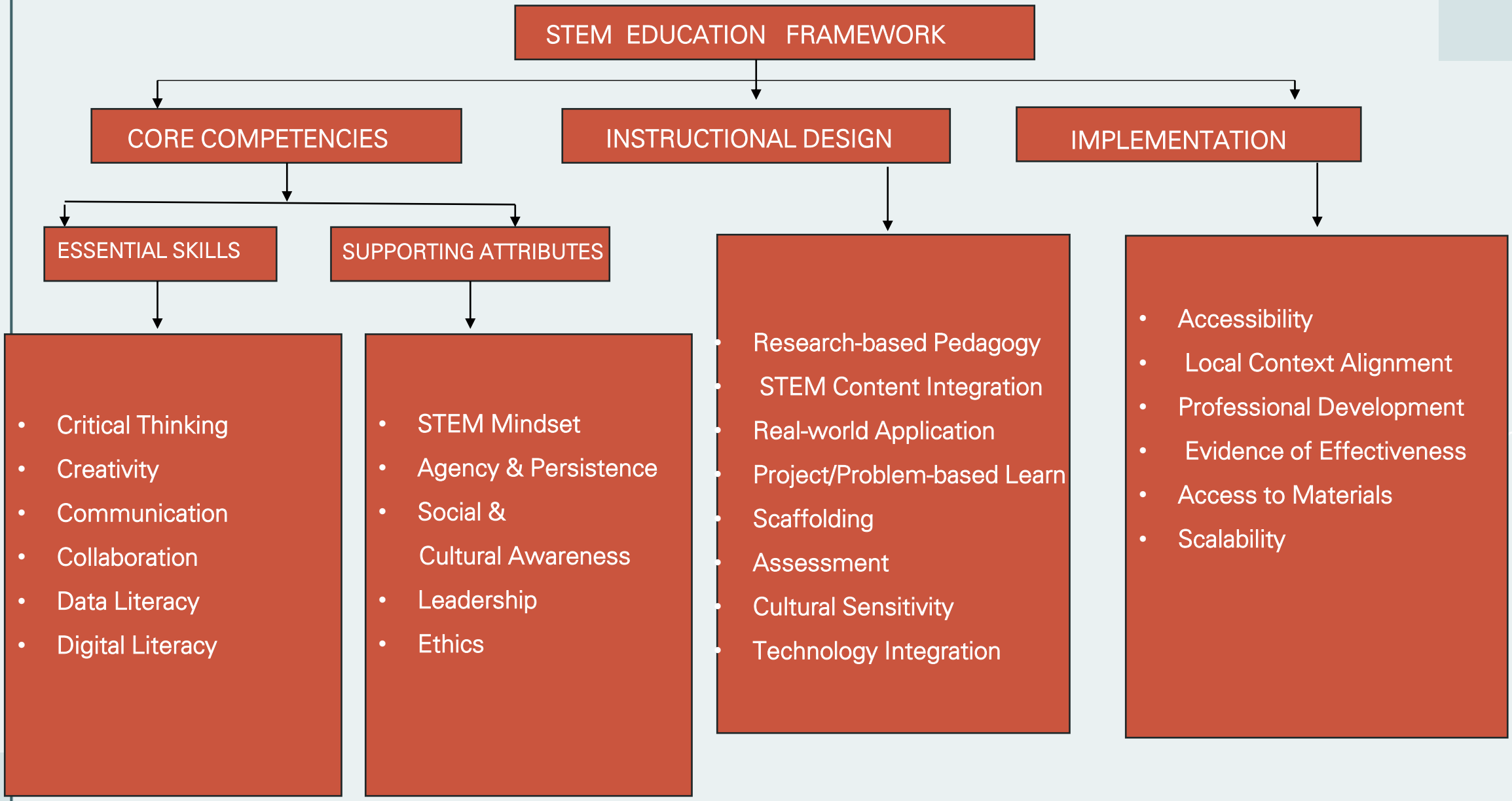
Agenda

- STEM Framework
- Design Thinking Model
- Implementing STEM

STEM Education Framework

- The STEM Education Framework, developed by the *Global STEM Alliance (The New York Academy of Sciences)*, provides a comprehensive guide for designing, implementing, and evaluating high-quality STEM (Science, Technology, Engineering, and Mathematics) education programs.
- It is structured into three core pillars, each with specific components and measurable criteria.


STEM EDUCATION FRAMEWORK
CORE COMPETENCIES
INSTRUCTIONAL DESIGN
IMPLEMENTATION
ESSENTIAL SKILLS
SUPPORTING ATTRIBUTES
Critical Thinking
Creativity
Communication
Collaboration
Data Literacy
Digital Literacy
STEM Mindset
Agency & Persistence
Social & Cultural Awareness
Leadership
Ethics
Research-based Pedagogy
STEM Content Integration
Real-world Application
Project/Problem-based Learn
Scaffolding
Assessment
Cultural Sensitivity
Technology Integration
Accessibility
Local Context Alignment
Professional Development
Evidence of Effectiveness
Access to Materials
Scalability

1. Core Competencies

Skills and attributes students need to thrive in STEM fields.

A. Essential Skills

Skill	Exemplary Criteria
Critical Thinking	Students evaluate multiple sources, test hypotheses, and apply perspectives (e.g., design thinking).
Problem Solving	Students generate solutions using scientific methods and design thinking.
Creativity	Novel approaches are explicitly valued; students express unique perspectives.
Communication	Students use multi-modal methods (e.g., models, presentations) to convey ideas.
Collaboration	Group work includes assigned roles and co-construction of knowledge.
Data Literacy	Students engage with qualitative/quantitative data and analyze ethical implications.
Digital Literacy	Technology tools are integrated with supports for students/teachers.

Critical Thinking (Example)

Exemplary	Developing	Basic	Undeveloped
Students evaluate multiple sources, test hypotheses, and critique work.	Students evaluate sources but not as integral to activities.	Limited opportunities to review primary materials.	No opportunities to evaluate evidence.

B. Supporting Attributes

Attribute	Exemplary Criteria
STEM Mindset	Encourages curiosity, objectivity, and flexibility.
Agency & Persistence	Failure is treated as a learning opportunity.
Social & Cultural Awareness	Includes diverse perspectives and links to social studies.
Leadership	Students practice initiative and consensus-building.
Ethics	Discusses ethical responsibilities in STEM.

Problem Solving (Example)

Exemplary	Developing	Basic	Undeveloped
Students generate multiple solutions with teacher support.	Students generate solutions but lack depth.	Single solutions are encouraged.	Step-by-step activities only.

2. Instructional Design

How STEM content is taught effectively.

Component	Exemplary Criteria
Research-based Pedagogy	Methods align with documented research.
STEM Content Integration	Multidisciplinary approach (e.g., science + math).
Real-world Application	Problems mirror real-life challenges.
Project/Problem-based Learning	Collaborative, long-term projects.
Scaffolding	Supports for varying student abilities.
Assessment	Formative/summative with rubrics.
Cultural Sensitivity	Values diverse perspectives.
Technology Integration	Tools enhance learning and collaboration.

Real-world Application (Example)

Exemplary	Developing	Basic	Undeveloped
Content linked to local STEM industries.	Content linked to real-world but not localized.	Scenarios lack relevance.	No real-world connection.

3. Implementation

Ensuring programs are practical and scalable.

Component	Exemplary Criteria
Accessibility	Follows Universal Design for Learning (UDL).
Alignment to Local Contexts	Adaptable to regional policies/cultures.
Professional Development	Ongoing teacher training and coaching.
Evidence of Effectiveness	Rigorous evaluation data available.
Access to Materials	No barriers to resources.
Scalability	Flexible distribution (e.g., online).

Professional Development (Example)

Exemplary	Developing	Basic	Undeveloped
Ongoing coaching and mentoring.	Pre-implementation training only.	Limited resources.	No support provided.

Focus Areas

- **Core Competencies** focus on skills + mindset (e.g., critical thinking, ethics).
- **Instructional Design** ensures effective teaching methods (e.g., real-world projects).
- **Implementation** guarantees practical delivery (e.g., teacher training, scalability).

Example Case:

A school using this framework might:

- Teach educational technologies via educational resources and problem-based approaches in a collaborative manner (Core Competencies).
- Use project-based learning with local industry partnerships (Instructional Design).
- Provide online teacher training and UDL-compliant materials (Implementation).

Design Thinking Model

Basic Notion of Design Thinking Model

Design thinking is a methodology that provides a solution-based approach to solving problems.

It’s extremely useful when used to tackle complex problems that are ill-defined or unknown—because it serves to understand the human needs involved, reframe the problem in human-centric ways, create numerous ideas in brainstorming sessions and adopt a hands-on approach to prototyping and testing.

When you know how to apply the five stages of design thinking, you will be empowered because you can apply the methodology to solve complex problems that occur in our companies, our countries, and across the world.

Design thinking is a non-linear, iterative process that can have anywhere from three to seven phases.

We will focus on the five-stage design thinking model proposed by the Hasso Plattner Institute of Design at Stanford because they are world-renowned for the way they teach and apply design thinking.

What are the 5 Stages of the Design Thinking Process ?

The five stages of design thinking are:

Empathize: research your users' needs.

Define: state your users' needs and problems.

Ideate: challenge assumptions and create ideas.

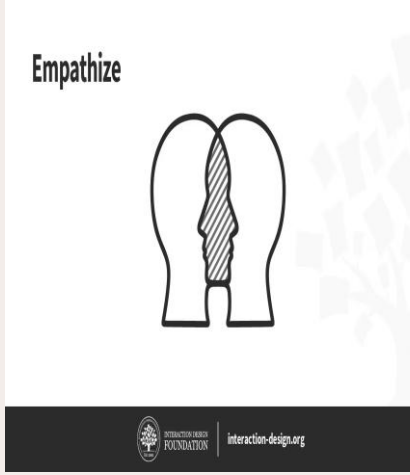
Prototype: start to create solutions.

Test: try your solutions out.

Stage 1: Empathize—Research Your Users' Needs

The **first step of the design thinking process**, known as **Empathize**, is all about developing a deep understanding of the **people you're designing for**. It's the foundation of human-centered design and focuses on **user-centric research**—meaning everything starts with the user.

In this stage, your main goal is to **truly understand the user's needs, problems, and experiences**. To do this, you:



- **Consult experts** to gather background knowledge on the topic.
- **Observe and interact with users** to see things from their perspective.
- **Immerse yourself in the users' environment** to better understand their challenges and behaviors.

The key to this phase is **empathy**—putting yourself in the user's shoes. This allows you to **set aside personal biases and assumptions**, so you can identify **real, unspoken needs** and **underlying issues** that might not be obvious at first glance.

By the end of this step, you'll have collected a **rich pool of information** that forms the basis for the next phases of design thinking. Essentially, the **Empathize** stage ensures that whatever solution you come up with later on is **rooted in genuine human needs**, not guesses or assumptions.

Stage 2: Define—State Your Users' Needs and Problems

1. Define the Problem Statement:

- This stage is about clearly articulating the core problem based on insights gathered during the Empathize phase.
- The goal is to develop a problem statement that is human-centered, not business- or technology-centered.

2. Analyze and Synthesize Observations:

- Organize the data collected in the Empathize stage.
- Identify patterns, user needs, and key challenges.
- Filter the insights to uncover the most meaningful problems that need to be solved.

Stage 2: Define—State Your Users' Needs and Problems

3. Human-Centered Framing

- Problem statements should reflect users' perspectives, not company goals or internal desires.

❌ Bad example:"We need to increase our market share."(Company-focused)

✅ Good example: "Teenage girls need nutritious food to thrive."(User-focused)

4. Inspire Ideation

- A well-defined problem statement guides the next phase—Ideation.
- It acts as a springboard for creative solution-finding by asking "How might we…" questions, which are: Open-ended, Solution-focused, User-driven

5. Purpose of the Define Stage

- Clarify what problem you're solving and for whom.
- Set a clear direction for ideation by defining the user's true need.
- Enable your team to generate solutions that are relevant, feasible, and meaningful.

Stage 3: Ideate—Challenge Assumptions and Create Ideas

1. Generate Innovative Solutions

- The Ideate phase is all about coming up with creative ideas to solve the problem defined earlier.
- This step builds on the user insights from Empathize and the problem statement from Define.

2. Problem to Possibilities

- Designers begin to look at the problem from different angles and explore a wide range of possible solutions.
- It encourages breaking out of obvious or traditional approaches to find more innovative ideas.

3. Emphasis on Creativity and Free Thinking

- At the start of ideation, the goal is quantity over quality—generate as many ideas as possible, without judgment.
- Use techniques like: Brainstorming, Brainwriting, Worst Possible Idea, SCAMPER-These methods expand the problem space and push boundaries.

4. Evaluate and Refine Ideas

- Toward the end of the Ideate phase, you start to filter and assess the ideas.

- Focus on identifying solutions that are either: Directly effective, or Contain key elements that could lead to a viable solution.

Stage 4: Prototype—Start to Create Solutions

In the **Prototype** phase, the design team creates **simple, low-cost versions** of the product or parts of it. These models help test the **ideas** that came up during the **Ideate** stage.

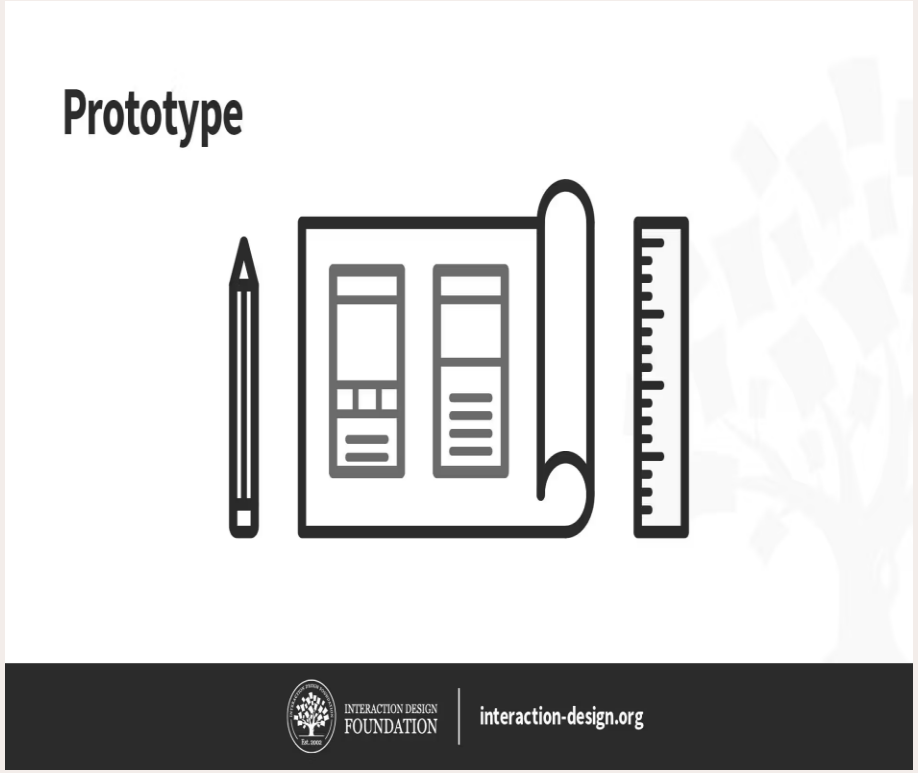
The goal is to **experiment** with different solutions and see what works best. These prototypes are tested by the team, other departments, or a small group of users.

Each solution is added to a prototype and then:

- **Accepted**,
- **Improved**, or
- **Rejected**—based on how users respond.

By the end of this stage, the team understands:

- What the **product's strengths and weaknesses** are, and
- How **real users** will likely feel, think, and act when using it.



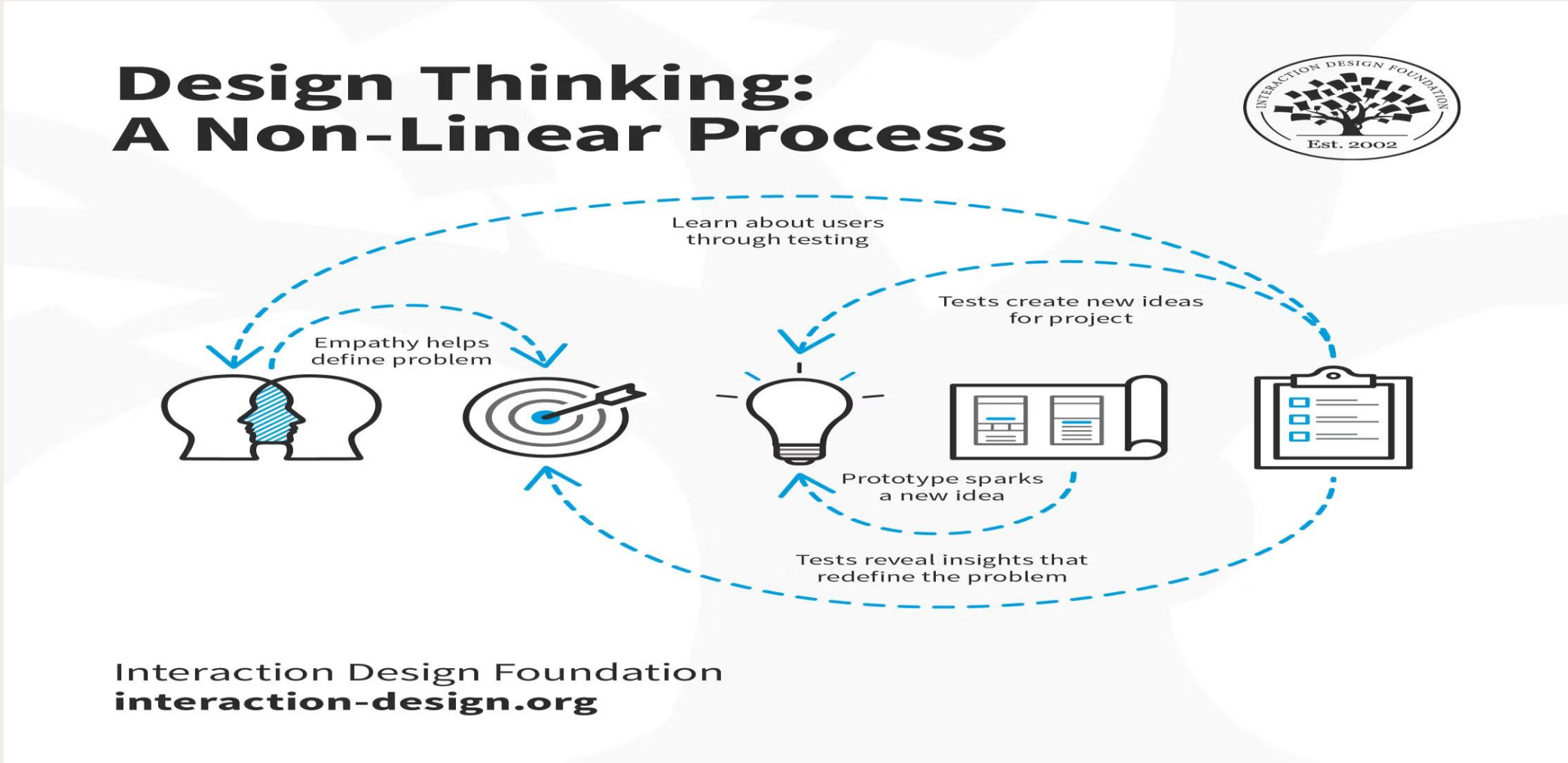
Stage 5: Test—Try Your Solutions Out

- In the **Test** stage, you try out the **solutions** you created during the **Prototype** phase.
- Designers test the **complete product** to see how well it works for real users.
- Even though it's the last phase, **Design Thinking is an iterative process**. That means you might discover new problems or better solutions during testing, which can send you back to earlier stages like **Empathize** or **Define**.
- Testing helps you understand:
- How users **think, feel, and behave** when using your product
- What needs to be **improved or changed**
- Which ideas should be **kept, refined, or removed**

The main goal?

-To gain a **deep understanding** of the **product** and the **users** before finalizing your design.

It is important to note the five stages of design thinking are not always sequential. They do not have to follow a specific order, and they can often occur in parallel or be repeated iteratively. The stages should be understood as different modes which contribute to the entire design project, rather than sequential steps.



How can the Design Thinking process be effectively applied to enhance STEM education? Brainstorm and explore its potential benefits.

Prepare a self-made example of Design Thinking.

The End