Engineering Design Challenges in the STEM Classroom

Making STEM a Meaningful Experience

Group Expectations

- ✓ Participate
- ✓ Professional
- ✓ Positive
- ✓ Prompt

- C O M M U N I C A T I O N
- C O L L A B O R A T I O N
- F L E X I B I L I T Y
- P E R S I S T E N C E
- P R E S E N T A T I O N
- I N N O V A T I O N
- T E C H N O L O G Y

Trainer:

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STEMscopes

Comprehensive K-12 Digital Curriculum

Created by Teachers for Teachers

Designed for your specific standards

STEMcoach™

The 5 E Instructional Model

The 5-E Model is for STEM!

-The staple of quality science instruction
-Intervention and acceleration help both struggling and advanced learners to be successful

Engineering Design Challenge

Making STEM a Meaningful 3D Experience

STEMcoach™

Are you STEM Ready?

Self Assessment

Novice

- Not aware
- no understanding of the practice
- not using practice at all.

Gaining Skill

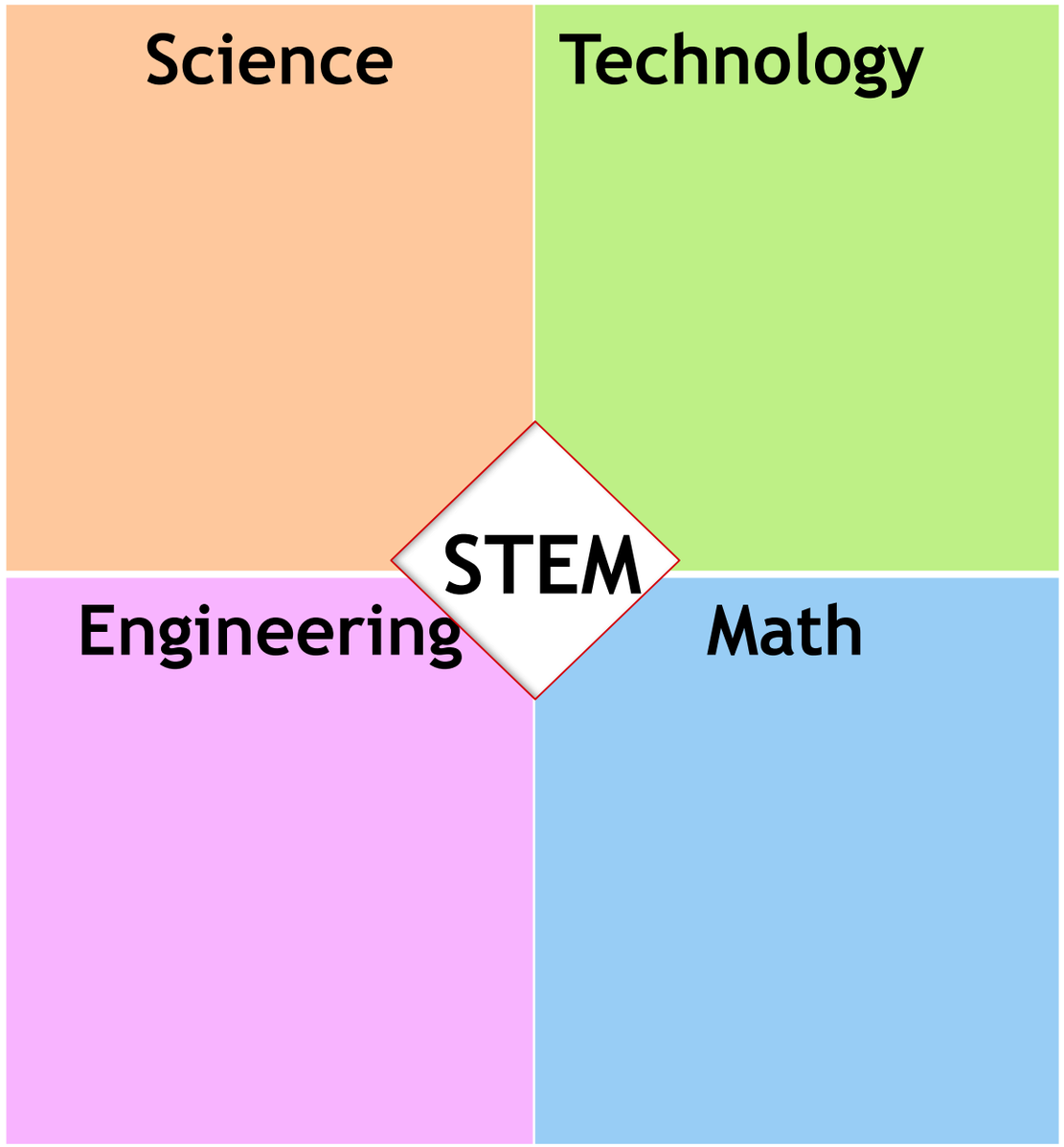
- Basic understanding of the practice
- not using the practice frequently.

Proficient

- Understanding of the practice and
- using the practice regularly as needed.

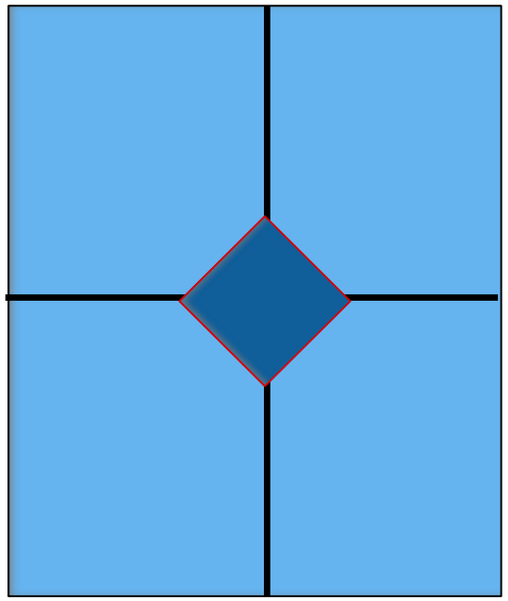
What is STEM?

- Write a definition for each content area in STEM



Defining STEM?

- **Science** – Science seeks to explain the natural world through observations and investigations.
- **Math** – Math is a language used to solve problems
- **Technology** – Technology is procedure, system, idea or tool that improves and extends our ability
- **Engineering** – is the designing of technology used to solve problems.



STEM is Engaging in The Practices of Scientists and Engineers:

1. Asking questions and defining problems
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations and designing solutions
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Engaging in The Practices of Scientists and Engineers

Practices of Scientists and Engineers to Design an *Earthquake Proof Tower*

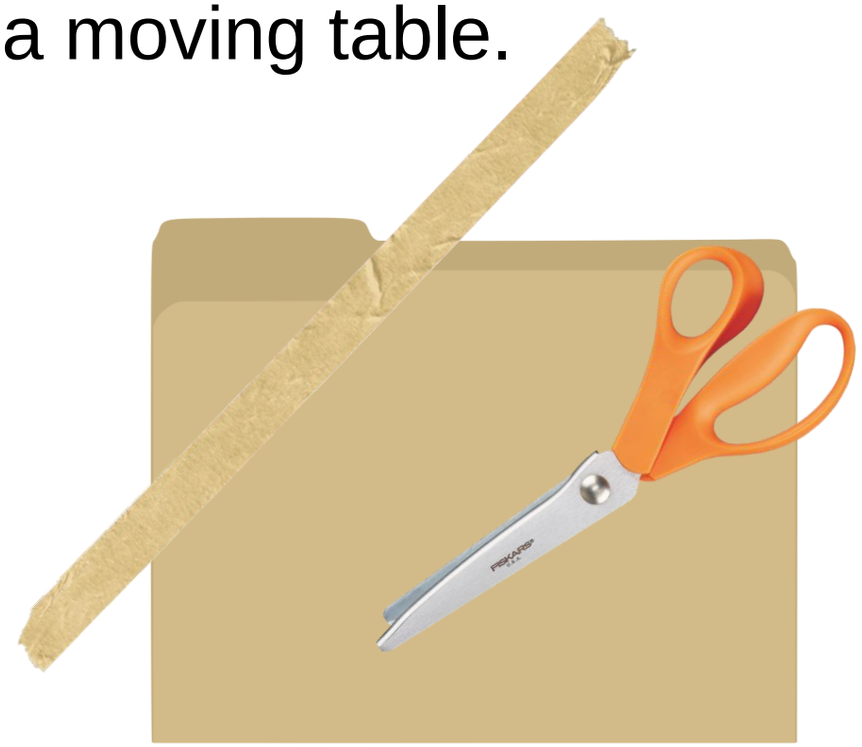
Challenge: Create a tower that can survive the waves created on the Earth's surface during an earthquake.

Criteria:

- Brainstorm with your team of 4-5, and have a drawn plan
- Remain standing for 10 seconds, on a moving table.
- Be of a height of least 3 feet or more

Constraints:

- 1 file folder
- 60 cm masking tape
- 5 minutes to plan
- 15 minutes to build



Reflection on Tower Building Work

Rate your group on the following:

1. To what level did your members work as a team?
2. To what level did your tower meet the criteria?
3. To what degree was your tower able to withstand the forces exerted by the earthquake?
   - What was your innovation?
4. To what extent were your team members able to explain the transfer of energy from the table to the tower?
5. What would you do differently next time?

Engineering Design Process

- Using the package of cards given to you, divide them evenly among your group

- Use consensus in a Round Robin fashion to place them in the order you did each in the construction of the tower.

What is Consensus?

You have consensus if you can state the following:

1. I have been heard and understood.
2. I have heard and understand.
3. I can live with it.
4. I can (and will) publicly support it.

-- from Capturing Kids Hearts

Engineering Design Process

- Using the package of cards given to you, divide them evenly among your group
- Use consensus in a Round Robin fashion to place them in the order
- Be creative and do not think of it as a linear process

You will have 10 minutes.

Protocol for Discourse

One person distributes the cards evenly to the group by dealing them out. Do not reveal your cards until your turn.

Person #1 places one card in the center of the table

Person #2 places one card before or after the original card.

- Make a claim: "This card should go before/after ____ because…"
- State the evidence to support the claim.
- Justify it's placement. Answer clarifying questions.
- Team members provide additional evidence to support the claim or refute the claim with other evidence.

Proceed around the table, placing one card per person at a time.

- Repeat the process of Claim, Evidence, Reasoning

Continue for all 15 cards, you will have 10 minutes.

Gallery Walk – One Stays the Rest Stray

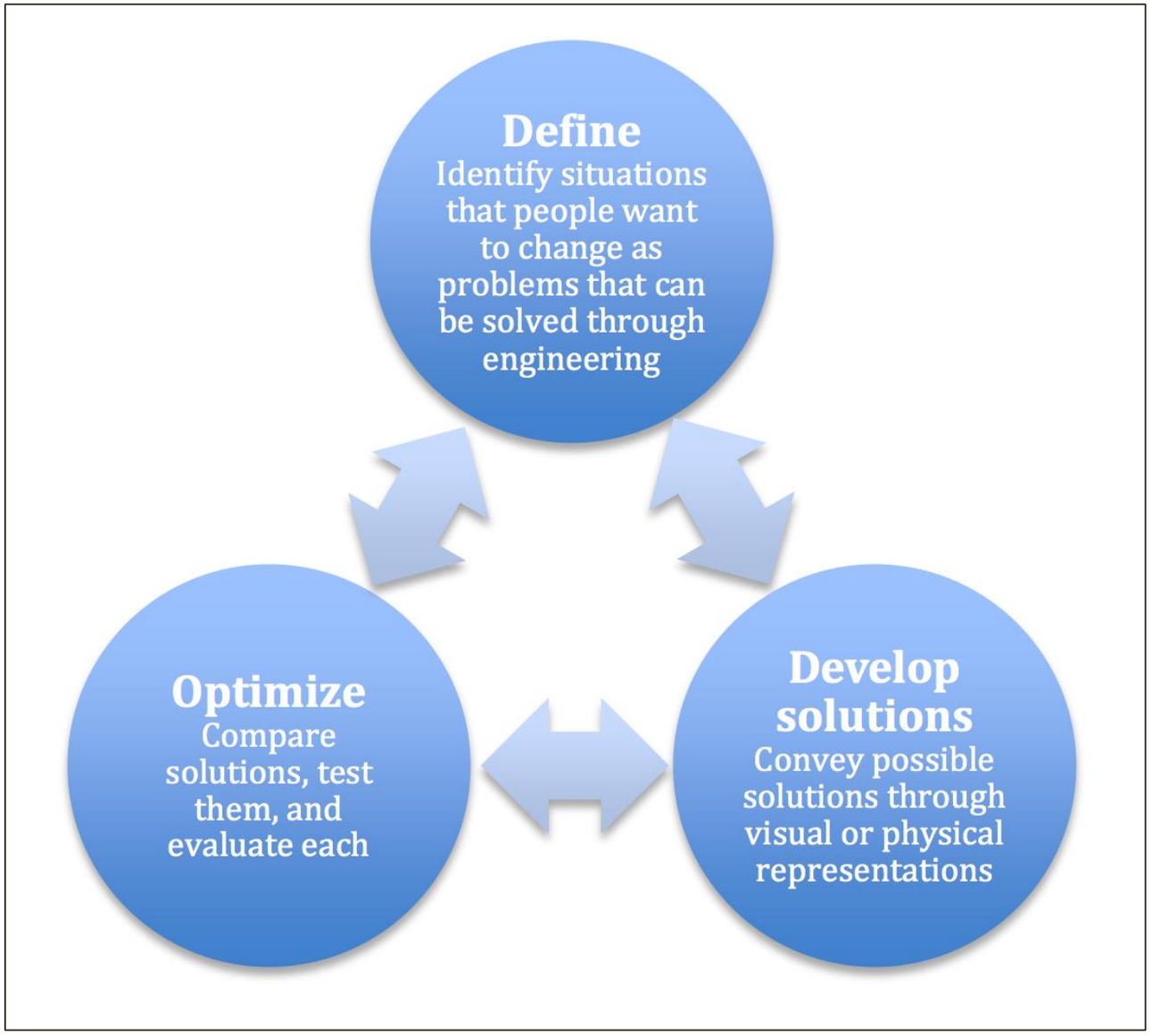
- A person from your group to be chosen to be the spokesperson
  Rehearse what they will say to reflect the groups' thinking

- Divide up your group to each go to a different table.
  Each person goes to only one other table.

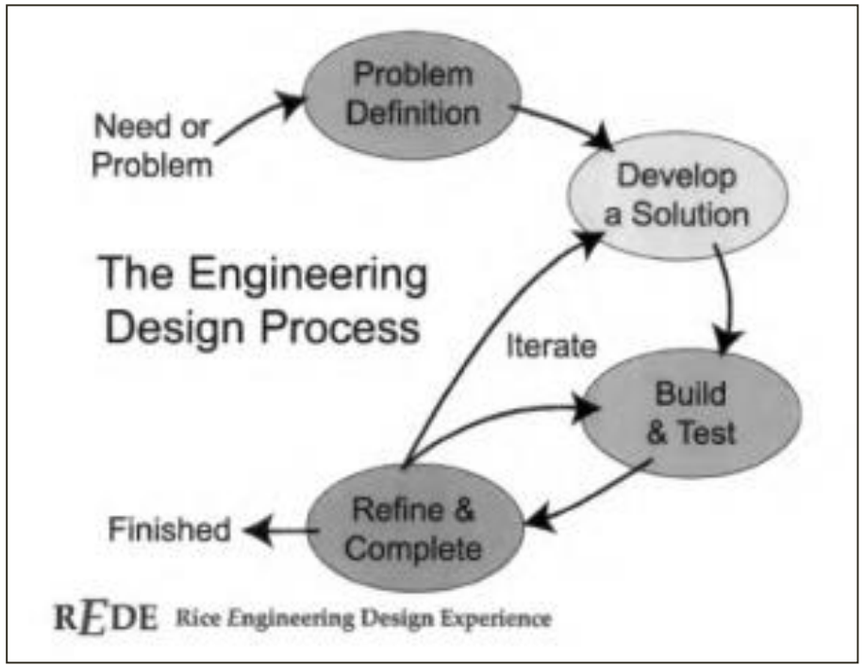
- Listen to the presenter and ask clarifying question.

- Return to your home group and report out your new findings.
  Discuss with your group if you want to change the order of your EDP.

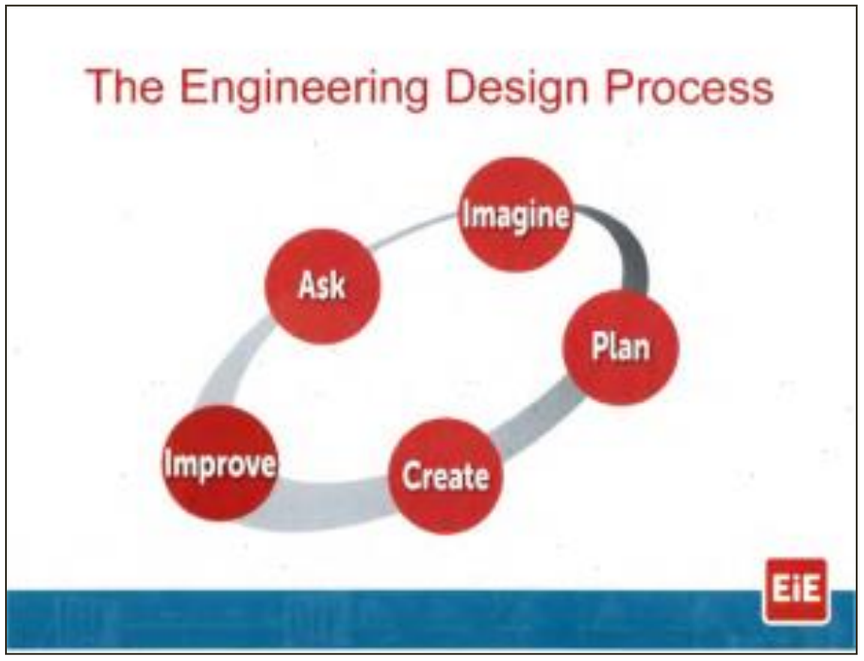
Engineering Design Process



Engineering Design in the K-12 Framework and the NGSS

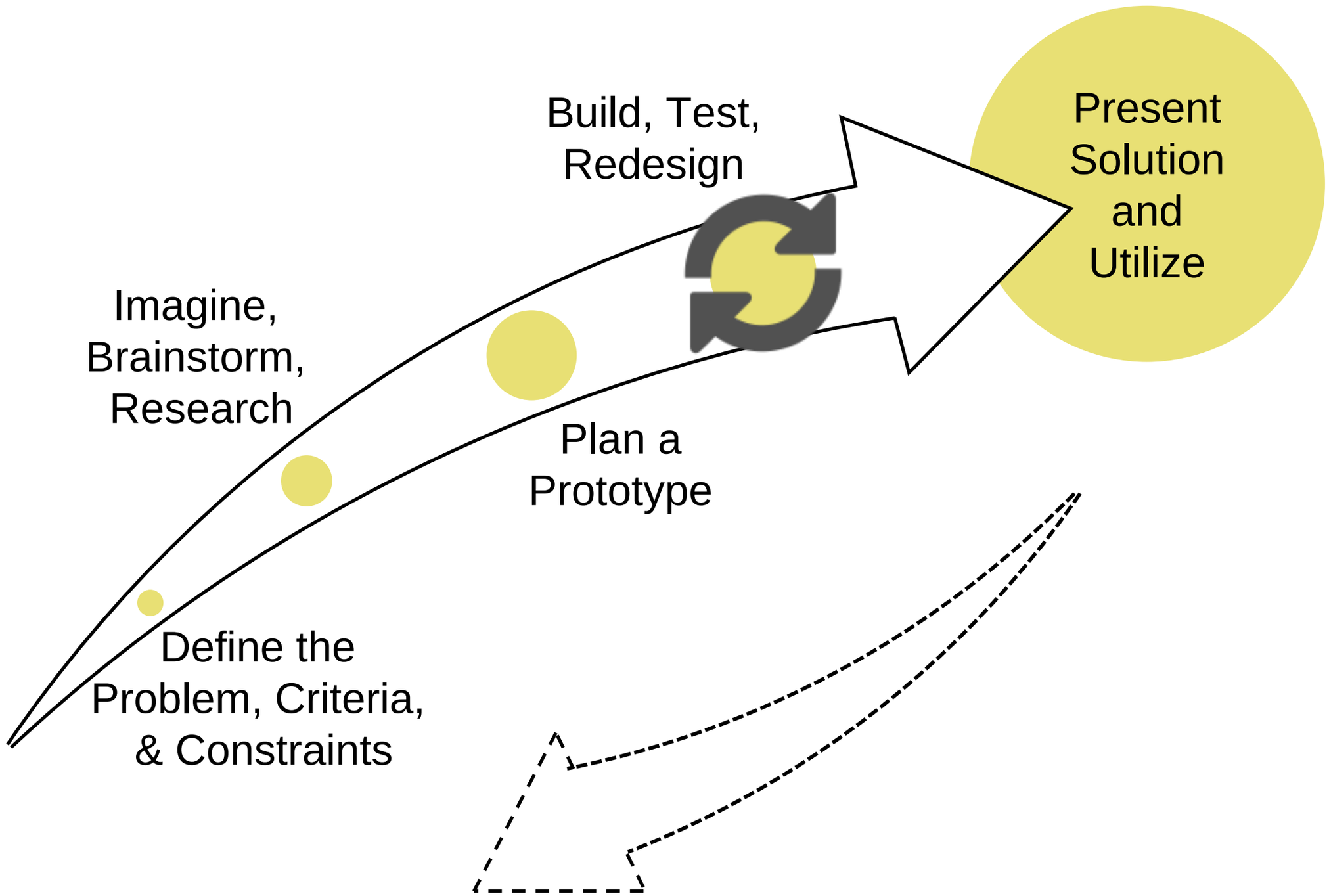


Rice Engineering Design Kitchen



Engineering is Elementary, Science Museum of Boston

Engineering Design Process



Redefining Failure as the “Next Step” in Building Persistence

Engaging in 21st Century Skills

Collaboration

Communication

Presentation

Creativity-Innovation

Integration of Technology

Persistence

Critical Thinking

Reflection Questions

- When thinking about incorporating Engineering Design into your science classroom what do you think the purpose of science is in the EDP?
- Why is it brought into your science standards?
- Share with three others in the room

HandUp, StandUp, PairUp process.

Final Thoughts

"We have not succeeded in answering all of your questions. The answers we have found only serve to raise a whole set of new questions. In some ways, we feel we are as *confused as ever*, but we believe we are confused on a *higher level* and about much more *important things*!"

Thank you!

Dive-In Engineering

- Partnership with NY Hall of Science
- Maker Movement
- Grades 3-8

- Agnostic to STEMscopes
- Available Fall 2017

Get STEM Certified

- Individual Teachers
- School-level
- District-wide

getstemcertified.com

DIVE in Engineering

https://www.acceleratelearning.com/dive-in/

Call AMY CANALES
(915) 309-0539
to learn more about the
Online Resources available through STEMscopes.

Thank you for your participation and engagement!

Engineering Design Challenges

Dropbox Folder Link for:
PDF of the Presentation, Handout and EDP Cards

Call AMY CANALES at (915) 309-0539

to learn more about the Online Resources available through STEMscopes.

Visit our Booth to receive a 30-Day FREE Preview of our Online Curriculum!!!

Using the Practices of STEM & The NGSS Standards

The Engineering Design Process

Students who demonstrate understanding can:

4-PS4-1. **Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move.** [Clarification Statement: Examples of models could include diagrams, analogies, and physical models using wire to illustrate wavelength and amplitude of waves.] [*Assessment Boundary: Assessment does not include interference effects, electromagnetic waves, non-periodic waves, or quantitative models of amplitude and wavelength.*]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. • Develop a model using an analogy, example, or abstract representation to describe a scientific principle. - ***Connections to Nature of Science*** **Scientific Knowledge is Based on Empirical Evidence** • Science findings are based on recognizing patterns.	**PS4.A: Wave Properties** • Waves, which are regular patterns of motion, can be made in water by disturbing the surface. When waves move across the surface of deep water, the water goes up and down in place; there is no net motion in the direction of the wave except when the water meets a beach. *(Note: This grade band endpoint was moved from K–2.)* • Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks).	**Patterns** • Similarities and differences in patterns can be used to sort, classify, and analyze simple rates of change for natural phenomena.

Connections to other DCIs in fourth grade:
4.PS3.A ; **4.PS3.B**

Articulation of DCIs across grade-levels:
MS.PS4.A

Common Core State Standards Connections:

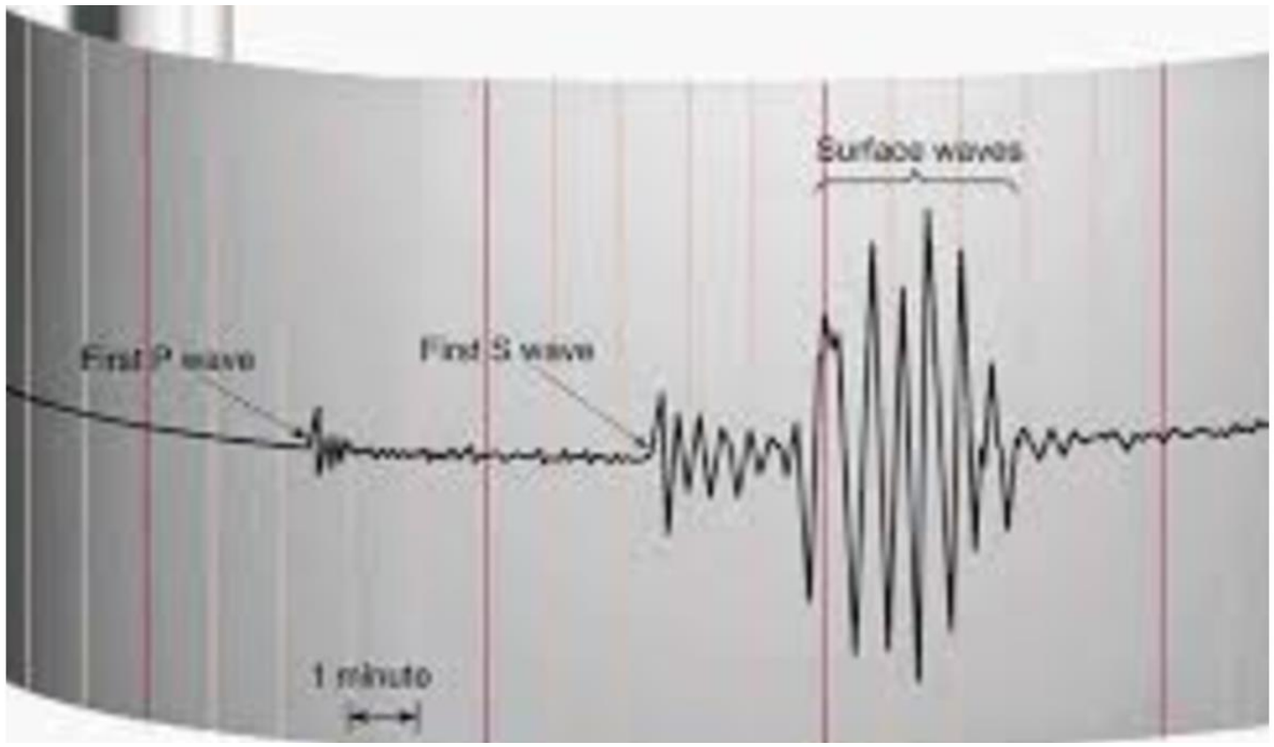
ELA/Literacy -
SL.4.5 Add audio recordings and visual displays to presentations when appropriate to enhance the development of main ideas or themes. *(4-PS4-1)*

Mathematics -
MP.4 Model with mathematics. *(4-PS4-1)*
4.G.A.1 Draw points, lines, line segments, rays, angles (right, acute, obtuse), and perpendicular and parallel lines. Identify these in two-dimensional figures. *(4-PS4-1)*

* The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.

Wavelength and Amplitude

Topic Physical Science | Grade Fourth Grade | Standards



Problem:

When an earthquake occurs, waves travel through the earth. These waves cause the crust to move as well as the buildings that are on top of the crust. These buildings are often damaged, some are even destroyed.

Located In Your Handout

Wavelength and Amplitude

Topic Physical Science | Grade Fourth Grade | Standards

Do

Name: _____ Date: ____

Waves in the Earth
Student Journal

The Problem

When an earthquake occurs, waves travel through the Earth's
waves cause the crust to move as well as the buildings that are
crust. These buildings are often damaged, some even destroy
California, where earthquakes are prone, and your family's ice
destroyed.

The Challenge

Create a structure that can survive the waves created on Earth'
an earthquake.

Criteria and Constraints

- Create a blueprint of a structure that will remain standing afte
- You can only use the materials provided by your teacher.
- You have 45 minutes to build, test, and refine your structure b
blueprint.
- All changes to your design must be included on your blueprin
- Your structure should be able to stand on a lightly shaken des

Design Team Expert _____

Material Engineer _____

Architectural Engineer _____

Mechanical Engine _____

Design Plan Notes:

Do

Waves in the Earth
Expert Roles

There are four expert roles, and your group needs to have at least on
will choose your role. The following roles are included:

- Design Team Expert
- Architectural Engineer
- Material Engineer
- Mechanical Engineer

Design Team Expert

As the design team expert, you will ensure your team successfully c
allowed amount of time. You will lead and keep track of all planning,
among engineers, and make sure all members of the team fully know
the plan. You and your team members will present your final product

Architectural Engineer

As the architectural engineer, you will ensure your team develops a
will guide the team through the activities to ensure all the required el
included in your design and presentation. You and your team memb
product.

Materials Engineer

As the materials engineer, you will research possible materials your
guide your team in selecting practical and durable materials. You an
present your final product.

Mechanical Engineer

As the mechanical engineer, you will ensure your team includes scie
design process. You will guide the team through the activities so all t
criteria and blueprint are included in your design and presentation. Y
will present your final product.

Do

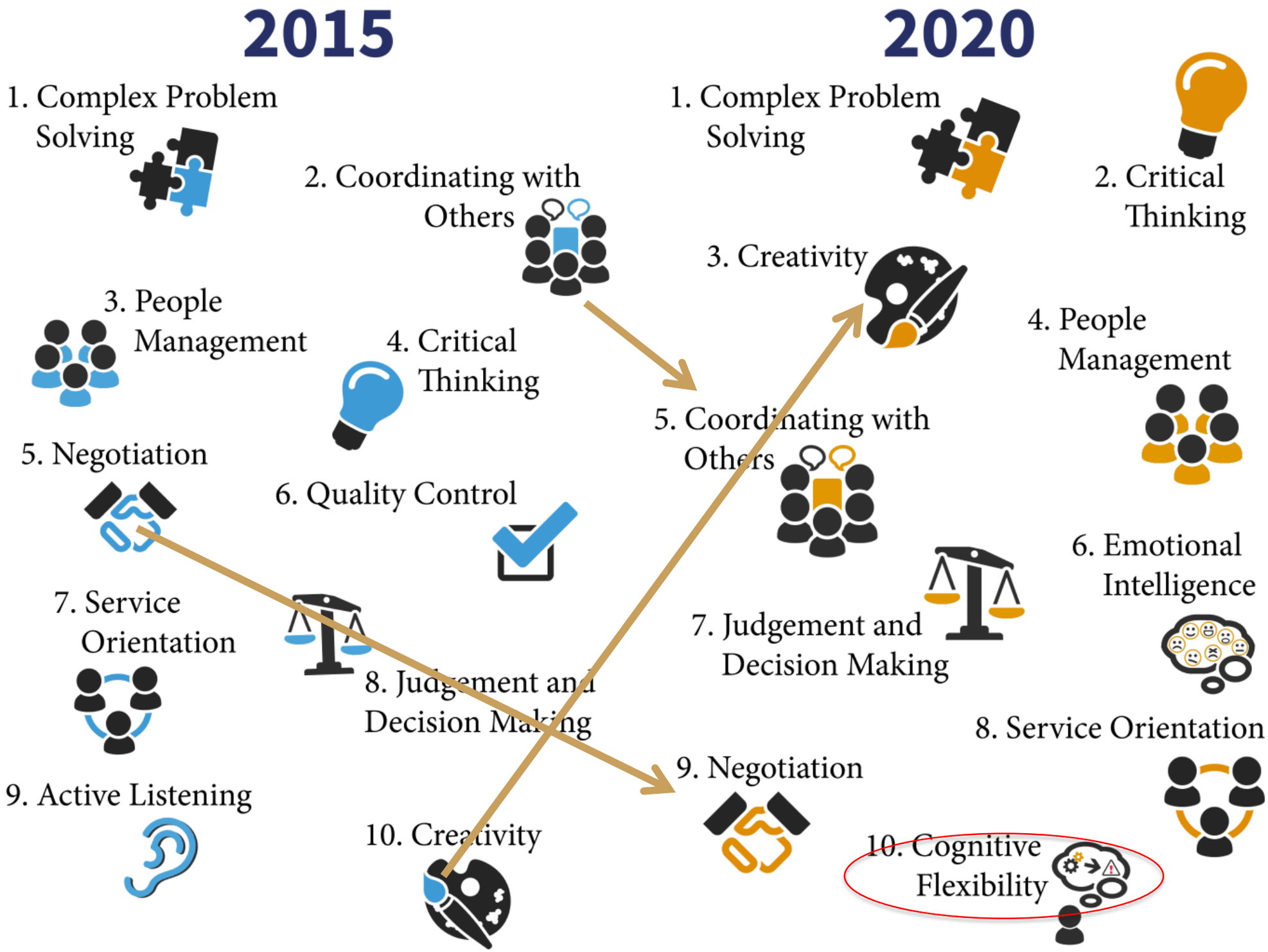
Waves in the Earth
Rubric

CATEGORY	Expert (4)	Competent (3)	Beginner (2)	Novice (1)
Product	The product is able to maintain it's shape after being lightly shaken for 10 seconds.	The product is able to maintain most of it's shape after being lightly shaken for 10 seconds.	The product maintains only some of it's shape after being lightly shaken for 10 seconds.	The product is not able to maintain it's shape after being lightly shaken for 10 seconds.
Criteria Expectations	All the criteria for the blueprint were followed.	All but one of the criteria were followed.	Only one aspect of the criteria was followed.	None of the criteria was followed.
Presentation	Explanations by all group members indicate a clear and accurate understanding of scientific principles underlying the design.	Explanations by all group members indicate a relatively accurate understanding of scientific principles underlying the design.	Explanations by most group members indicate relatively accurate understanding of scientific principles underlying the design.	Explanations by several members of the group do not illustrate much understanding of scientific principles underlying the design.
Teamwork	All members of the group worked together. Communication was respectful, and everyone was able to listen and be heard.	The members of the group worked together majority of the time. There was minor discord, but it was resolved with respect.	Members of the group struggled to work together. Some could work together, but as a whole, they could not work as a team.	There was no teamwork. Some people were completely left out of the group, and there were unresolved arguments.

@refthinking

(SOURCE: FUTURE OF JOBS REPORT, WORLD ECONOMIC FORUM)

TOP 10 SKILLS IMPORTANT IN THE WORKFORCE



RICE