STEM Education

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What is STEM Education

https://padlet.com/mnsyahrir1/ihda6odcw9o

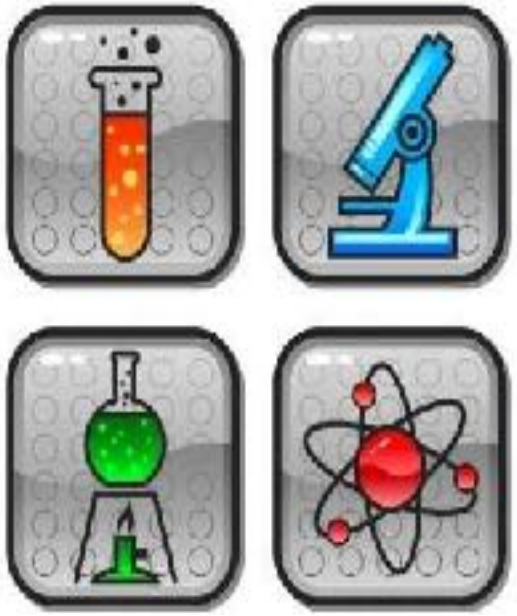
STEM

- What is STEM education?
- Is it a new subject replacing science & math?
- Why STEM education matters?
- What is STEM literacy?
- How can an elementary teacher in self-contained classroom begin to create STEM lessons?
- How can content-specific teacher work with others to connect the STEM disciplines with each other and with language arts, social studies, art and music?
- How does STEM teaching and learning promote 21st century skills?

STEM Education

- Interdisciplinary approach to learning.
- Removes traditional barriers separating the four disciplines:
  - Science
  - Technology
  - Engineering
  - Mathematics
- Integrates into real-world, rigorous and relevant learning experiences.

Why is STEM Education Important?

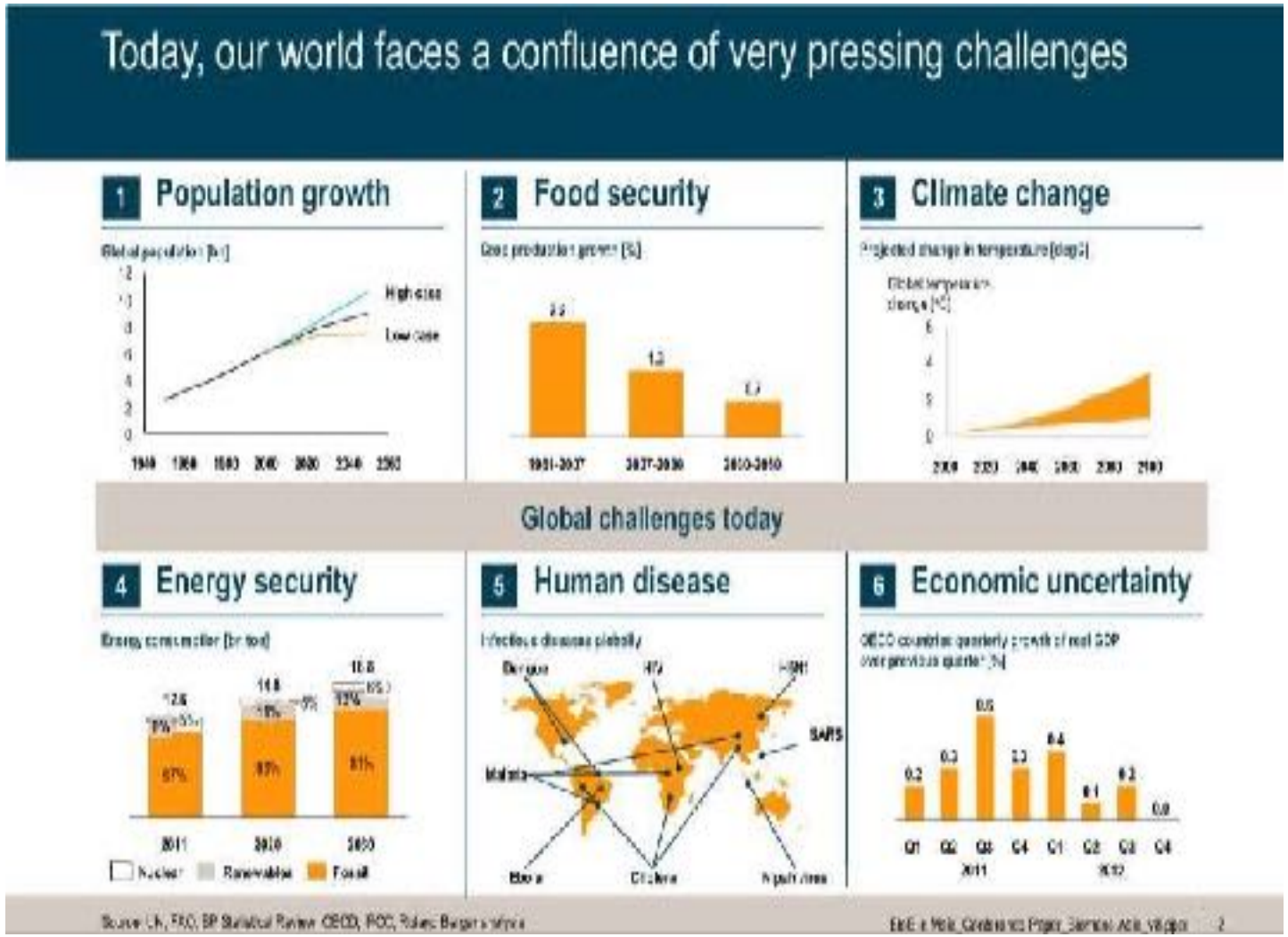


The future needs Science, Technology, Engineering and Mathematics (STEM)

STEM cannot solve all of the worlds problem but neither can we face the future without it.

Many countries have started to provide STEM education to equip their future generation to be solution providers

Global Challenges in the 21st Century



The problems of climate change, poverty, food security ,water security and the growing world economy, all depend on a population well-educated in STEM

Emphasizes 21st-Century Skills

Critical thinking and problem solving,
Communication,
Collaboration,
Creativity and innovation

Problem-solvers
Innovators
Inventors
Self-reliant

Prepare them to become citizens who are able to make decisions about personal, health, energy efficiency, environmental quality, resource use and national security

STEM Literacy

- What is the goal of STEM education?

The main goal of STEM education is not for students to become mathematicians, scientists, technicians, or engineers; although it would be great if more of youth had such aspirations.

The goal is for all students to be able to function and thrive in our highly technology world – STEM literate.

What is STEM Literacy?

Scientific Literacy - National Research Council (2012)

- The study of the natural world – knowledge of the key facts, concepts, principles, laws, and theories in the science disciplines.
- Able to connect these ideas across disciplines
- Practices and ways of thinking that advance our knowledge of the natural world as well as use science to solve real-world problems.

Technology Literacy - International Technology and Engineering Education Association (2007)

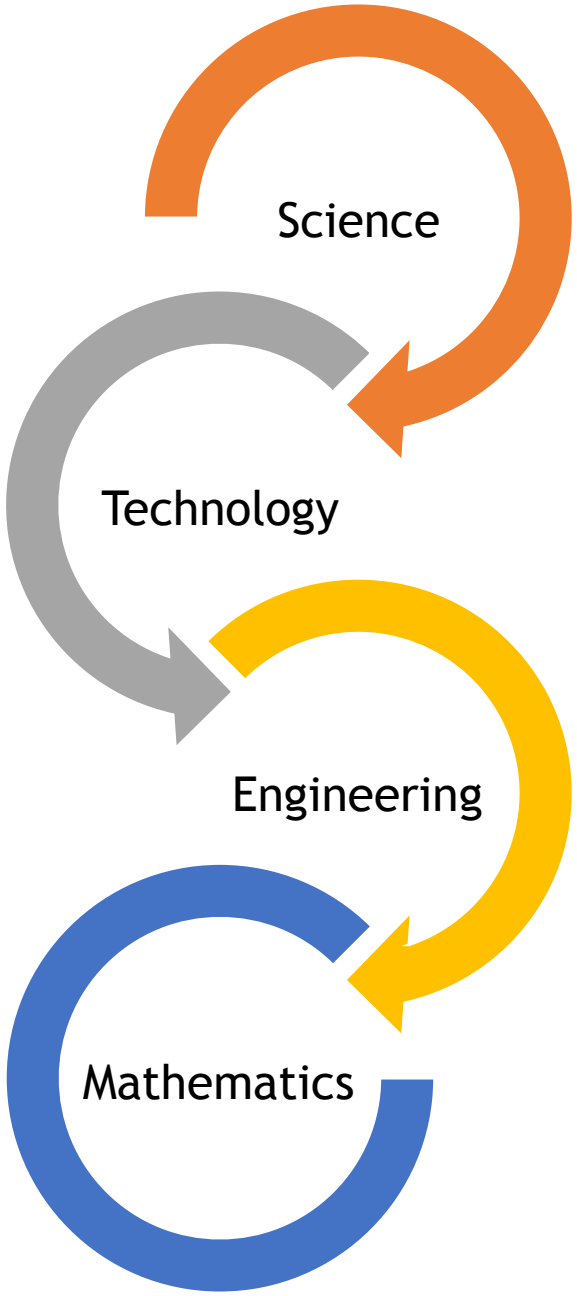
- the ability to use, manage, understand, and asses technology.
- Any product created that was used to solve a problem is technology – paper, pencil, buildings, electric power grid, satellite and internet.

Engineering Literacy

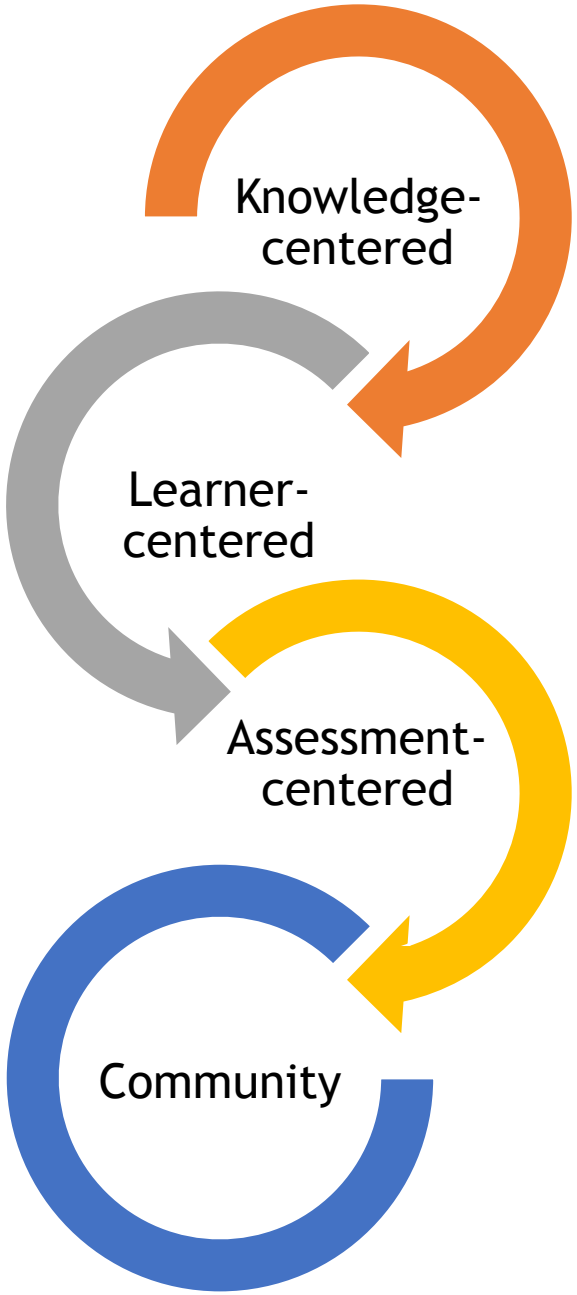
- Able to solve problems using by applying the engineering design process.

Mathematical Literacy

- able to express mathematical ideas in words, to participate in discussions about mathematics, and to apply the concepts and skills of mathematics to everyday life.



- STEM is not a “new” subject/ single subject that replaced several others.
- Students still need to learn the same concept and skills in science and mathematics.
- Students need to understand and able to use many different types of technologies and how to solve problems through engineering design process.



- **Knowledge-centered** - what we want our students to know and be able to do as a result of the learning experience. Develop fundamental knowledge, skills, and attitudes.
- **Learner-centered** - connect the strengths, interests, and preconceptions of learners to their current academic tasks and learning goals and help students learn about themselves as learners.
- **Assessment-centered** - monitor and make visible of students' progress.
- **Community** - classroom, the school, and the neighbourhood where the student lives.

STEM EDUCATION TODAY

- STEM education today is not about teaching the subject disciplines but rather HOW do you harness knowledge in the STEM subjects to provide solutions to real-life problems
- How do you CONNECT the knowledge learnt in the disciplines concerned to provide creative and innovative solutions to real life problems and even to the extend that the solutions be of commercial viability so that we can create new and competitive industries for the country
- In other words we do not want the students to learn about electrons but cannot connect how TV functions
- We also cannot have students learn about biology but cannot connect with teenage pregnancy

Guiding Principles for STEM Teaching

Focus on Integration

- combining 2 or more of disciplines - help the students see the relatedness of the concepts.
- generate more innovative & creative solutions – considering opportunities to apply their understanding & think more broadly.

Establish Relevance

- important to convey how the knowledge will be useful.
- why should I learn about this?
- does it address a real-world problem?
- can I get a better job if I know about this?

Emphasize 21st Century skills

- it is not how much knowledge the students possess but how they can assess the information when needed and how they use the information to creatively solve problems and communicate the ideas and concepts effectively.

Challenge Your Students

- it is important to plan tasks that are nor so difficult that students give up, nor so easy that students find the work boring.
- emphasize on 21st century skills allow a greater range of participations from all students.

Mix it Up

- provide a variety of outcomes.
- include both Problem-based approach & project-based approach.

Vasquez, Sneider,, & Comer (2013).

IDEAL STEM LESSON

- STEM lessons focus on real-world issues and problems. Students will address social, economic and environmental problems and seek solution eg. Climate change causing malaria on the rise
- STEM lessons are guided by the engineering design process.
  - Students required to IDENTIFY the problem, conduct background research, DEVELOP multitude of ideas for solutions, develop and CREATE a prototype, test and evaluate and redesign them.
  - Students come out with their own research ideas , take different approaches, make mistakes, accept and learn from them, try again.
  - They focus on developing the solutions.

Real-world issues

IDENTIFY Problem

Background research

Provide SOLUTION

DESIGN the solution

CREATE prototype

TEST and EVALUATE

RE=DESIGN

IDEAL STEM LESSON

- Hence today's STEM lesson goes BEYOND preparing students for the job market.
- STEM lessons develop thinking skills, reasoning, rationalization, teamwork, investigative and creative skills that students can use in ALL aspects of their lives
- CONCEPT of STEM lesson should be for all disciplines
- It is OK to fail
- You learn from your failures

Real-world issues

IDENTIFY Problem

Background research

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CREATE prototype

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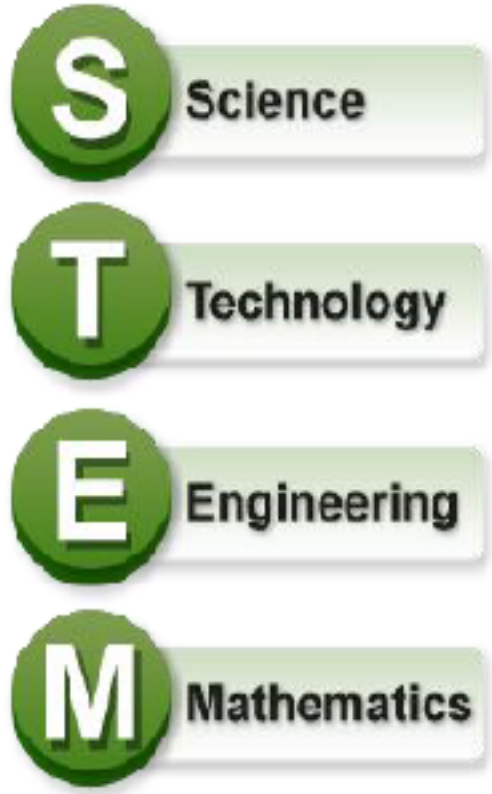
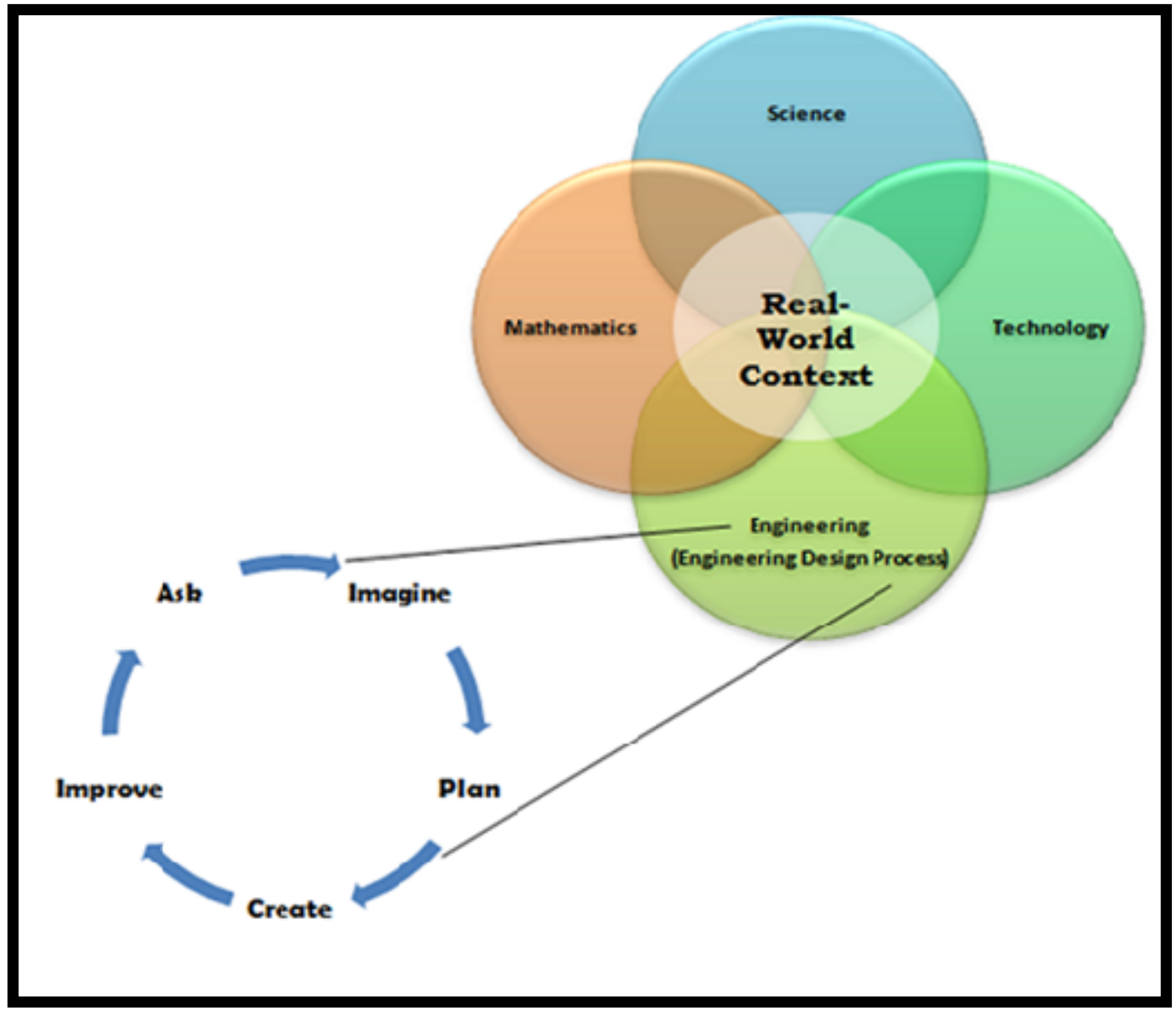
What is integrated STEM Education?

- STEM integration is a **curricular approach that combines the concepts of STEM in an interdisciplinary teaching** approach (Wang et al. 2011).
- It **could include combination of two or more components of STEM** (Becker & Park 2011)
- Curriculum is **student-centered** and grounded in the **real-world application of content**.
- Involve active learning through STEM-Centric Pedagogy – **Problem-based**, **Project-based and Inquiry-based**




Science
Mathematics
Real-
World
Context
Technology
Engineering
(Engineering Design Process)
Ask
Imagine
Plan
Create
Improve

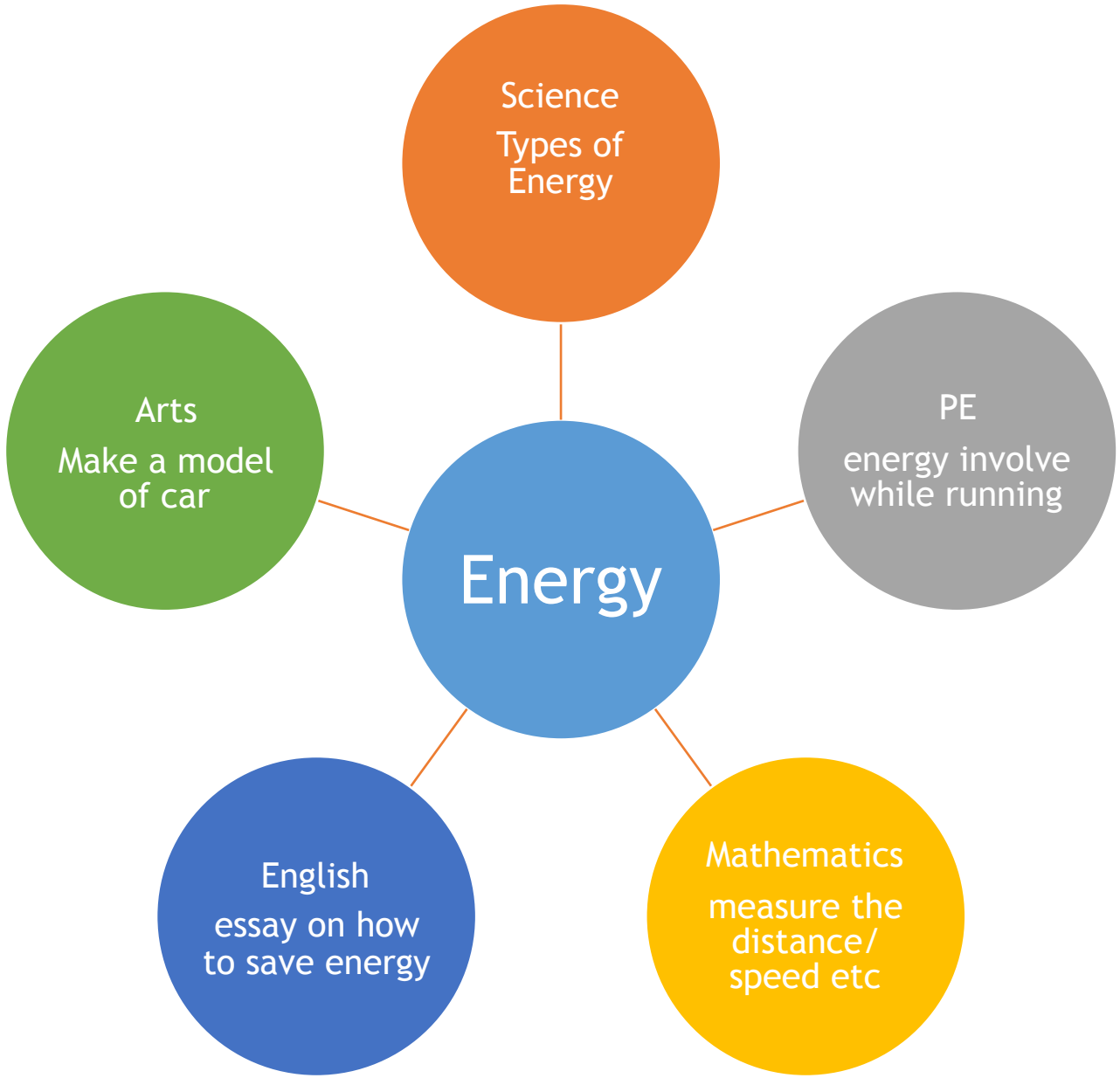
Engineering Design Process

Why engineering design?

- STEM integration should involve **"engineering design" as a basis for creating connections to concepts from mathematics or science** (or both) (Sanders 2009).
- Engineering design process through STEM integration can act **as a connector for meaningful learning** the content of mathematics & science (Moore et al. 2013).
- Can provide a gateway to turn the abstract science and mathematics concepts into concrete real-life applications.

Design process	Description
Ask	What is the problem? How have others approached it? What are your constraints?
Imagine	What are some solutions? Brainstorm ideas. Choose the best one
Plan	Draw a diagram. Make lists of materials you will need.
Create	Follow your plan and create something. Test it out!
Improve	What works? What doesn't? What could work better? Modify your designs to make it better. Test it out!

Multidisciplinary Integrated STEM



STEM to STEAM

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What is STEAM

- What is STEAM?
  - *STEAM is an educational approach to learning that uses Science, Technology, Engineering,* ***the Arts*** *and Mathematics as access points for guiding student* ***inquiry, dialogue, and critical thinking****. The end results are students who take thoughtful risks, engage in experiential learning, persist in problem-solving, embrace collaboration, and* ***work through the creative process****. These are the innovators, educators, leaders, and learners of the 21st century!*
  - STEM is a building block for STEAM. **STEAM education makes its focus the *application* of science, technology, engineering and math through art and design.** Another way of looking at this is that STEAM educators can help students connect what they learn in these critical areas (STEM) with art practices and design elements. Ultimately, students should feel like they can wonder, critique, inquire and innovate.

Why STEAM?

- The critical process of creativity and innovation is missing.
- Our economy requires so much more than an understanding of STEM areas – it requires application, creation and ingenuity. STEM alone does not foster these essential nutrients.
- it allows students to connect their learning in these critical areas together with arts practices, elements, design principles, and standards to provide the whole pallet of learning at their disposal.
- removes limitations and replaces them with wonder, critique, inquiry, and innovation.

STEAM Model

- Integrated approach to learning which requires an intentional connection between standards, assessments and lesson design/ implementation

- Involve two or more standards from Science, Technology, Engineering, Math and the Arts to be taught AND assessed in and through each other

STEAM

- Inquiry, collaboration, and an emphasis on process-based learning are at the heart of the STEAM approach

- Utilizing and leveraging the integrity of the arts themselves is essential to an authentic STEAM initiative

STEAM Process

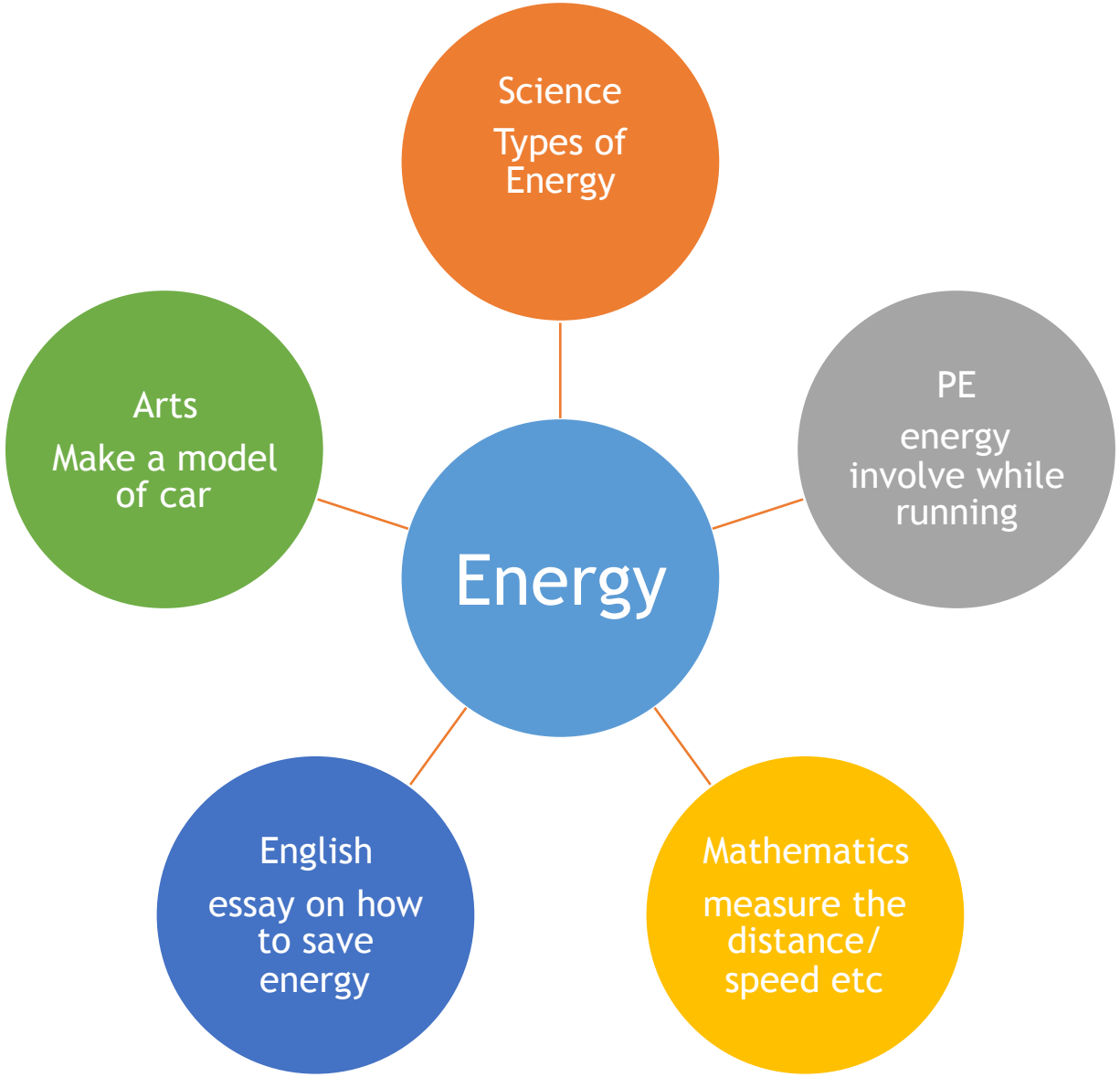
- Inquiry
  - deep questioning.
  - curiosity

- Critical Thinking
  - find solutions to a problem

- Process-based learning
  - being creative in the finding of the solutions.

STREAM?

- adds one more layer to STEM and STEAM: reading and wRiting.
- essential part of a well-rounded curriculum, as it requires critical thinking as well as creativity.
- STREAM projects are similar to STEM or STEAM, but fold in the components of reading and writing.


Science
Types of Energy
Arts
Make a model of car
PE
energy involve while running
Energy
English
essay on how to save energy
Mathematics
measure the distance/ speed etc

Build a Robot Hand

- Do you know anyone who has had a hand or an arm injured in an accident?
- What if you could build them a robotic hand to help them accomplish everyday tasks like writing, picking up a glass, or opening a door?

Resource: https://www.sciencebuddies.org/stem-activities/build-a-robot-hand#summary

STEM Assessment

- ongoing process aimed at understanding and improving student learning.
- good assessment inform how students are learning.
- how we are teaching and how to adjust and monitor our instruction to meet the needs of all our students.
- our students also need data on their own performance and how to move from where they are to where they need to be.

Interdisciplinary Assessment

- Integrated units (STEM, STEAM or STREAM) are built on standards and learning objectives from the disciplines.
- Most integrated STEM units also include important learning objectives that cut across the disciplines.
  - communication skills, cooperation, teamwork & problem solving.

STEM Assessment tools

- checklist
- rubrics
- classroom test
- maps
- self-assessments
- peer assessments
- graphic organisers
- concept maps
- portfolios
- conferences

- **Summative**
  - at conclusion of an instructional unit or segment.
  - tend to evaluate - score or grade.
- **Diagnostic**
  - pre-assessment. check students' prior. knowledge and skill levels to help them.plan instructional unit or to group students.
- **Formative**
  - concurrently instruction - ongoing monitoring activities - provide specific feedback to teachers and students - guiding the instruction and improve learning experience.
  - classroom assessment.
  - formal & informal.

Sharing Session

- Choose a theme/topic.
- Plan an activity.
- Integrate the element of STEM/STEAM/STREAM.
- Discuss 21st century skills integrated in your activity.
- Discuss the type of assessment that you can implement throughout the lesson.

Reflection

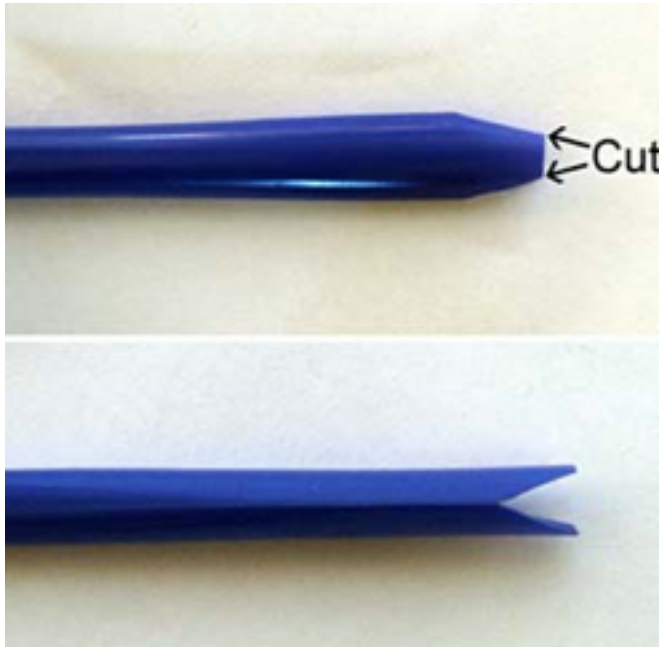
- Is STEM/STEAM/STREAM a curriculum? A strategy? A goal?
- What would you consider to be the major goal of STEM/STEAM/STREAM education?
- How can STEM/STEAM/STREAM teaching provide learning opportunities that are different from the traditional approach.
- Which of the guiding principles for STEM/STEAM/STREAM teaching do you already use in your own teaching?

Balloon Car

- Use materials you have to build balloon-powered cars.
- Your cars will need a body, wheels, and axles, and will be propelled forward by air escaping from a balloon.
- Design your car in the worksheet before you start building your car.
- The goal is to see who can build a car that travels the farthest before coming to a stop.
- Test and redesign your cars (as much as possible while time allows) before a final class competition.

“Do-Re-Mi Straw”

- Flatten about 2 centimeters (cm) at one end of a drinking straw.
- Use scissors to make two, small, angular cuts on each side of the flattened end.
- Next, make a series of three straw to play the three notes of a scale by varying their lengths



Ratio	Note
1/1	“do”
9/8	“re”
5/4	“mi”

Discussion

- What are the concepts learned in these activities?
- Discuss the element of STEM/STEAM/STREAM integrated in these activities.
- Discuss the other elements of STEM/STRAM/STREAM can be added in these activities.
- What are the 21st century skills integrated in these activities?
- What are the challenges you face throughout these activities?

References

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