PLTW GTT AR Science Frameworks

PLTW Course: GTT Automation and Robotics

Science Strand being addressed: Physical Science

Sub-strand being addressed: Motion

Science Standard being addressed 6.1.2.2

Overview:

Science Standard and Benchmarks: 6.1.2.2.1

Science Standard 6.1.2.2: Engineering design is the process of devising products, processes and systems that address a need, capitalize on an opportunity, or solve a specific problem.

Benchmark 6.1.2.2.1: Apply and document an engineering design process that includes identifying criteria and constraints, making representations, testing and evaluation, and refining the design as needed to construct a product or system that solves a problem.

Correlation to AAAS Atlas
MN 6.1.2.2 = AAAS 3B/M4a

Essential Understandings/Big Ideas:

Engineers and technologists design mechanisms to change energy by transferring direction, speed, type of movement, and force or torque.

Systems fail because they have faulty or poorly matched parts, are used in ways that exceed what was intended by the design, or were poorly designed to begin with.

The activities in this lesson introduce students to mechanisms that are used to change speed, torque, and force, type of movement, and direction of movement.

These mechanisms have been developed over time to address the need for changes in machine tools, robots, automobiles, airplanes, etc.

Individuals with these skills are high in demand and are needed to solve specific problems that are needed for the development of future technology to meet societal needs and wants.

What should students know and be able to do [at a mastery level] related to these benchmarks?

- Understand the design process.
- Construct a system that fits pre-determined criteria and solves problems.
- Be able to troubleshoot and identify the cause of a malfunction.
- Test and evaluate the product.

Misconceptions:

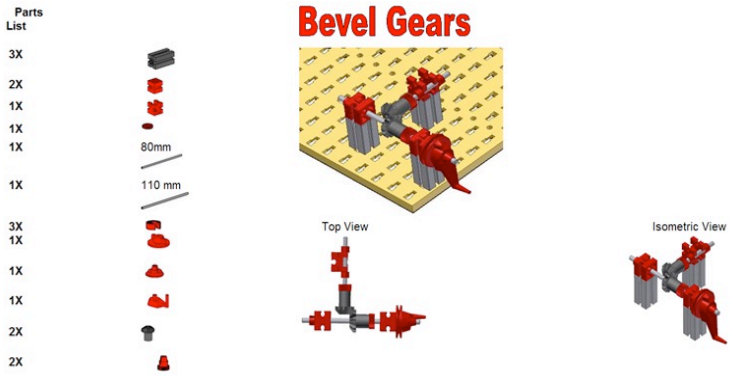
Student Misconceptions

- There is only one design.
- Criteria and constraints are not important.
- Evaluation and testing a product are not important.

Teacher Resources:

Teacher Notes

- The activities in this lesson will introduce the design process using mechanisms that are constructed to change speed, torque, and force, type of movement, and direction of movement.
- It is best to have physical examples of items that show simple gear movements to show students.
- Provide numerous moving examples of concepts being taught.
- Build sheets (example below) work well for students to follow as they construct and test mechanisms.



What is it that students struggle with the most and how can the teacher most effectively help students learn the concepts?

- Knowledge that designers have many options. Picking and choosing methods for each project works well.
- How to troubleshoot a malfunctioning system efficiently.
- Where are mechanisms used in real-life applications and what is their purpose.

Additional Instructional Resources

Engineering paradise
https://www.youtube.com/watch?v=Y0DxmthvkKU

Honda - The Power of Dreams
https://www.honda.com/?from=dreams.honda.com&from=dreams.honda.com#/video_wi

New Vocabulary

- **Constraint -** A factor that restricts a project or system to achieve a higher level of production.
- **Criteria -** A standard by which something can be judged or decided.
- **Efficiency -** The ability to bring a desired result with the least waste of time, energy, or material.
- **Feedback -** Information about the output of a system that can be used to make adjustments.
- **Innovation -** An improvement of an existing technological product, system, or method of doing something.
- **Limitation -** Some factor that restricts the scope of activity or accomplishment.
- **Malfunction -** To function imperfectly or badly.
- **System -** A group of interacting, interrelated, or interdependent elements or parts that function together as a whole to accomplish a goal.
- **Threshold -** A level or point at which something would start or cease to happen or come into effect.
- **Trade-off -** A balancing of factors, all of which are not attainable at the same time; giving up of one thing in return for another.
- **Troubleshoot -** Locating and finding the cause of problems related to technological products or systems.

Vignette:

- Design a product using several mechanisms that change energy by transferring direction, speed, type of movement, and force or torque. As students build different mechanisms they discover how systems fail due to misaligned or faulty parts.
- Consider constraints.

- Communicate ideas with drawings and simple models.
- Plan work.
- Use suitable tools and techniques to construct
- Evaluate the design.
- Suggest improvements.
- Try modifications.
- Identify solution.

- Teacher: Which mechanism changes rotary movement to linear movement?
  Student: Lead Screw.
  Teacher: What does it mean to significantly increase force?
  Student: A person can put a little force into turning the handle of a jack (lead screw) to move a heavy car.
  Teacher: What type of movement are we talking about?
  Student: Rotary
  Teacher: What type of output movement are we talking about?
  Student: Linear
  Teacher: What disadvantages do you see with this mechanism?
  Student: There is lots of pressure and friction on the threads which could cause mechanical failure.

Assessment:

Assessment Methods

Directions: Select the words in the chart below and write them in the spaces to answer questions #1 - #15. Some words may be used more than once or not at all.

Torque	Linear	Output	Gear Ratio
Worm & wheel gear	Mechanisms	Universal joint	Crown & pinion gear
Cam & follower	Rack & pinion	Same	Smaller
Larger	Bevel gear	Mechanical	Leadscrew
Rotary	Force	Increases	Speed
Opposite	Simple gear train	Reciprocating	Decrease

1. _____ are devices that can be engineered to transmit movement, change a type of motion into another, and change speed or torque.
2. A _____ travels in a straight line.
3. When a force travels in a circle or arc it is called _____.
4. In mechanisms, there is a relationship between torque and _____.

5. The end result of a device's activity is called its _____.
6. The output of all electric motors is what type of motion? _____
7. In a gear train, in order to increase speed, the driven (output) gear must be made _____.
8. In a gear train, when speed increases, _____ decreases.
9. _____is the engineering field that deals with mechanisms.
10. In a gear train, in order to increase torque, the drive (input) gear must be made _____.

11-12. Torque and Speed are inversely proportional. If one _____ the other must _____.

13. _____motion is made up of straight lines.
14. _____motion describes back and forth motion.
15. _____is the relationship between the number of teeth on two gears that are meshed together.

Differentiation:

Gifted and Talented

- Purposely provide faulty parts which would require more testing and evaluation to successfully solve the problem.

Special Education

- Students on an IEP and those who struggle could have extra handouts and related materials (computer simulations, videos and Internet links) made available to them.

English Language Learners

- Much of the vocabulary used in this area can be difficult for the ELL student. Using pictures shown in build sheets could help. Assembled models to be looked at would also be of assistance to the ELL students.
- This information would have to be reinforced through the help of the ELL teacher.

Parents and Administration:

Administrative/Peer Classroom Observation

Students Are:	**Teachers Are:**
Building mechanisms	Questioning students
Documenting problems	Monitoring progress
Adjusting and making changes	Reinforcing success

Testing and Evaluating	Redirecting problems

Professional Learning Communities:

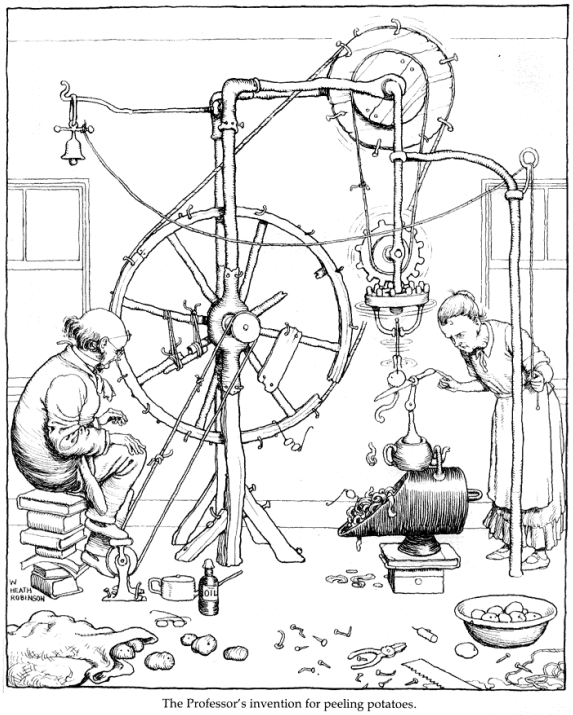
Reflection – Critical Questions regarding the teaching and learning of these benchmarks:

- In what areas did students perform best and what weaknesses are evident?
- How can this content be connected to other benchmarks in learning?
- Do students see the connection between different mechanisms?
- Are students interpreting information correctly?
- What areas did students perform best and what weaknesses?

Materials – suggested articles and books for book study with PLC ~ Careers in Engineering.

Parent Resources:

- Allowing their children to practice problem-solving skills at home. Combine old toys that have moving parts to create new toy with different functions.
- Encourage children to be willing to experiment with concepts that involve the design process.
- http://www.edheads.org/
- https://edheads.site-ym.com/default.aspx
- Examine the Rube Goldberg cartoon below. Find the input and locate the different mechanisms until you reach the final output of the cartoon.



The Professor's invention for peeling potatoes.

References:

- Project Lead the Way, Gateway To Technology, Automation and Robotics course curriculum
- Minnesota Academic Standards - Science K - 12 2009 version
- AAAS Benchmarks
- http://www.project2061.org/publications/bsl/online/index.php?home=true