PLTW GTT AR Science Frameworks

PLTW Course: GTT Automation and Robotics

Science Strand and Substrand being addressed

Strand: Physical Science Substrand: Motion

Science Standard being addressed 6.2.2.2

Overview:

Science Standard and Benchmarks

6.2.2.2.2

Science Standard: Forces have magnitude and direction and govern the motion of objects.

Benchmark: Identify the forces acting on an object and describe how the sum of the forces affects the motion of the object.

Correlation to AAAS Atlas:

MN 6.2.2.2 = AAAS 4F/M3a

Essential Understandings/Big Ideas:

Think about a bicycle, an eggbeater, a sewing machine, a hand cranked drill, and a workshop vice. What do they have in common? All of them have at least one mechanism that provides motion. A mechanism is a device that transmits movement so that the output motion is different than the input motion. A mechanism can be used to change force. The output of any machine is motion and force in some form. An force acting on an object changes its speed or direction of motion. A drill press, for example, has two kinds of motion: rotary and linear. The drill spinning provides the rotary motion; moving the drill down through the material is the linear motion. The force applied to the drill must be sufficient to turn the drill through the material.

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

- How to identify different types of forces and motion.
- Use their knowledge of mechanisms, to build a device that will perform a specific task.
- Understand how mechanisms work when different motions and forces are at work.

Misconceptions:

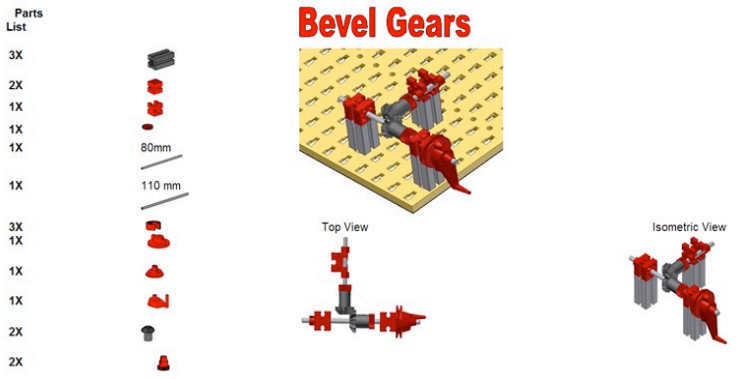
Student Misconceptions:

- Students will often confuse vocabulary when examining mechanisms. Example would be thinking that “Rack and Pinion” and Crown and Pinion” mechanisms are the same.
- Students will confuse different types of motion. Examples would be “Rotary” and “Reciprocating”.

Teacher Resources:

Teacher Notes

- The activities in this lesson will introduce the students to several mechanisms that are used 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?

- Vocabulary. Have posters and pictures to show and tell how new words relate to activities.
- They are unable to visualize concepts being taught. Instructor needs to teach small bits at a time.

New Vocabulary

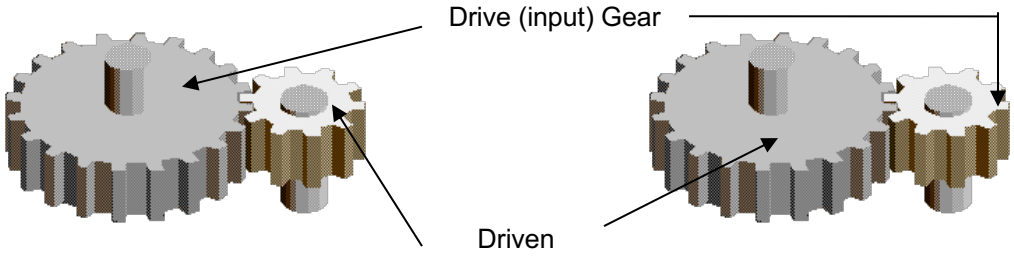
Belt & pulley	The transmission of power between shafts by means of a belt connecting pulleys on the shafts.
Bevel gear	One of a pair of gears used to connect two shafts whose axes intersect.
Cam & follower	A pear-shaped disk with an off-center pivot point, used to change rotating motion into reciprocating motion.
Crank & slider	A pivot pin near the outside edge of a wheel or disk that changes reciprocating motion into rotary motion.
Crown & pinion	A small cogwheel (pinion gear) that engages or is engaged by a larger cogwheel (crown gear).
Drive gear	The gear which transmits power and motion to the rest of the system. The input gear.
Driven gear	The member of a pair of gears to which motion and power are transmitted by the other. The output gear.
Energy	The ability to do work.
Force	A push or pull on an object.
Gear	A toothed wheel that works with others to alter the relation between the speed of an engine and the speed of the driven parts.
Gear ratio	The ratio of the speed of the driving member of a gear train to that of the driven member.
Idler gear	A gear between the driver and the driven gear used to change rotational direction.
Input	Something put into a system, such as resources, in order to achieve a result.
Inverse	Opposite in position, direction, order or effect.
Lead screw	A threaded shaft used to convert rotary movement to linear movement.
Linear motion	Movement in a straight line.
Mechanism	The part of a machine which contains two or more pieces arranged so that the motion of one compels the motion of the others.
Oscillate	A swing back and forth at a regular rate.
Output	The results of the operation of any system.
Pitch	The distance between adjacent threads in a screw.
Rack & pinion	A rotating gear that meshes with a bar that has gear teeth along its length. Changes rotating motion into linear motion.
Ratio	The quantitative relation between two amounts showing the number

	of times one value contains or is contained within the other.
Reciprocating	A back and forth movement.
Rotary motion	Circular movement.
Simple gear train	A combination of two or more gears used to transmit motion between two rotating shafts or between a shaft and a slide.
Torque	A twisting force.
Universal joint	A joint that allows connected shafts to spin freely while permitting a change in direction.
Work	The application of force that moves an object a certain distance.
Worm & wheel	A mechanical arrangement consisting of a toothed wheel driven by a short revolving cylinder bearing a screw thread.

Vignette:

The activities in this lesson will introduce the students to several mechanisms that are used to change force and motion. Use a bench vice as an example of rotary motion (input) and linear motion (output) creating a significant increase in force. Students will build different mechanisms and discover how they are used in the world today.

Teacher: When you are riding a multi-speed bicycle up a steep hill, what do you do?
Student: You shift gears so you can get more power with the same amount of effort.
Teacher: Gears turn in a circular direction. There is a relationship between torque and speed in gearing. A ten-speed bicycle has ten different gear selections. When you pedal up a hill, you use a gear train that provides more torque (turning force) but, in doing so, less speed. When you pedal on flat land, you use a gear train that provides more speed, but in doing so, less torque within the gear train.
The gear train in which diagram below provides more torque?
The gear train in which diagram below provides more speed?



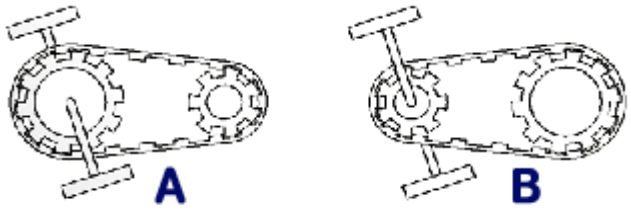
Additional Instructional Resources

- Mechanisms PowerPoint *(in Google Docs GTT Resources / Automation and Robotics)*

Assessment:

Assessment:

Gears turn in a circular direction. There is an inverse relationship between torque and speed in gearing. A ten-speed bicycle has ten different gear selections. When you pedal up a hill, you use a gear train that provides more torque (turning force) but, in doing so, less speed.
When you pedal on flat land, you use a gear train that provides more speed, but in doing so, less torque within the gear train. When pedaling up a hill we trade-off speed for torque, in other words a reduction in speed is a trade-off to increase torque and make pedaling easier.
The drive gear is the input gear; the driven gear is the output gear. Label the drive and driven gears in the two diagrams below.



The gear train in which diagram provides more torque? __**B**___
The gear train in which diagram provides more speed? ___**A**__
Which gear train would you use to ride up a hill? _**B**____

Fill in the chart below to show the relationship between torque and speed in gear trains.

More Torque	**Less Speed**
More Speed	**Less Torque**

Differentiation:

Gifted and Talented:

- This activity could be expanded by requiring these students to combine multiple uses of concepts being taught on the same project.

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 which are shown in build sheets could help. Assembled models which could 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: (descriptive list)	**Teachers Are:** (descriptive list)
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 types of mechanisms?
- Are students interpreting information correctly?
- What areas did students perform best and what weaknesses?

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

Parent Resources:

- Parents can help their child learn about force and motion as they use common cooking tools in the kitchen. An ice cream scoop being a good example of Rack and Pinion movement. The lid of a jar of peanut butter is a good example of a Screw.
- http://www.heath-teach.com/science_force_motion_and_simple_machines

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