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V2.3

THREE WHEELS ON THE CART.:

LESSONS

WHEELS & AXELS

2nd & 3rd grade
teacher plan

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Lesson 4: THREE WHEELS ON THE CART..:

This lesson invites students to add one more wheel and explore how the mechanical advantage of wheels, plus the added stability of more wheels, offers more design choices.

Objectives:

Students will practice what they learned about transportation, work, effort, and mechanical advantage with more wheels, while still being challenged with a design constraint. At the end of this lesson, students will better understand that creating stability/safety when enabling speed is desirable.

Vocabulary used in this activity:

vehicle, advantage, benefit, mechanical advantage, request, specific, constraint, environment, flexible, feedback, situation

Standards

NGSS **K-2nd Engineering Design:** K-2-ETS1-2 Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem. K-2-ETS1-1 Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool | **K2 ETS1 and 3-5 ETS1:** Engineering and design | **3 PS2** Forces and motion

CCSS-Math MP1, MP5, MP6, MP7

CCSS-ELA SL.2.1, SL.2.1.A, L.2.1, L.2.2, L.2.3, W.3.8, W.3.1b, CCRA.I.6, RF.3a.4a

Time needed: 35-45 minutes

Materials and Supplies:

Gingerbread friend, paper, pencils/crayons, Brackitz planks (1x1 and 1x2), and 3 and 4-way hubs, as well 1-way pivoting hubs. Give out exactly three tires and axle-splines and six lock washers to each group.

Resources/Optional Reading:

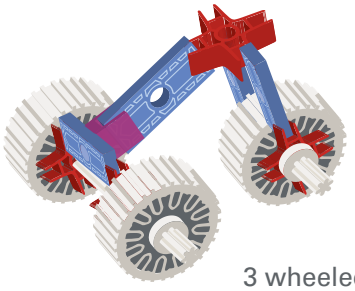
Richard Scarry's Cars and Trucks and Things That Go and Gail Gibbons's Transportation: How People Get Around

Set-up and Preparation:

Prepare trays of building materials ready to be handed out; help students cooperatively form groups of 2-3 to work together.

Background Knowledge:

Prior to this lesson, students do not need special background knowledge. Introducing students to the Gingerbread friend from Unit 1 can help them keep a user in mind who will use their designs.



3 wheeled example

brackitz connecting imaginations

Lesson 4: THREE WHEELS ON THE CART.

35-45 minutes

Whole Class - Wheel Prediction

10 minutes

"Based on how many wheels we've used each day, make a prediction on how many wheels we'll use today. (Three!)

Yes, today we will think about three-wheeled vehicles. Have you ever seen three-wheeled vehicles? What were they? (Wheelbarrows, certain ATVs, dune buggies, some bike trailers, and some baby strollers.) How/where were they used? What do you think the specific advantage of a three-wheeled vehicle might be?" (If you need a vehicle that can be a bit flexible or get through rough, narrow, or twisty spots, having three wheels can provide some stability while also making a vehicle that's a bit adjustable.)

Instructor Notes and Tips

Three wheels is not as common. Help students consider that these vehicles may be used for special circumstances, like hiking with a baby stroller or moving rocks with a wheelbarrow.

When asking what the specific advantage of a three-wheeled vehicle is, if students are struggling, help them look at designs of a couple examples (hiking baby strollers or bike trailers) noting that often this involves one wheel in front to twist and maneuver and two wheels in back for stability. Also point out where/how these vehicles are usually used: spots with rough surfaces and a need to move safely while also making some narrow or challenging turns.

Group Exploration - 3-Wheeled Design

10 minutes

"You're going to keep practicing your design constraint, but today you get exactly three wheels. Design a three-wheeled vehicle for our Gingerbread friend. Where will this vehicle be most useful to the Gingerbread? Are there situations where this vehicle would be better than your one or two-wheeled designs?"

Many students will design something that looks a lot like their Lesson 2 wheelbarrows. This is because they had one wheel and assumed in the design that the two legs of the user would balance. Now, with three wheels, those two legs can be replaced with two wheels. Point this out and discuss the similarities and reasons for this!

You can have kids look at their one and two-wheeled carts. Ask them to describe and draw how they would modify these designs to add a third wheel. Share these ideas before having the class begin building their three-wheeled carts.

It will be important to reserve the pictures of three-wheeled designs in this lesson for your reference and not show students at this stage, as this will give them a solution before they've created anything. But, you can ask students to think about a place Gingerbread would like to have this vehicle: where would s/he like to go and what would s/he like to do? (Driving around a beach, moving our toys out of the way to make a new Gingerbread building in the classroom, etc.) Then ask how three wheels can help us design something that's the right size for the Gingerbread friend and will work in that environment.

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Group Challenge

15 minutes

"Build a vehicle design with EXACTLY three wheels as the design constraint. How and where will Gingerbread use it? When you test it, what CRITERIA must these three-wheeled designs meet to be useful?"

This is a chance for students to begin building. Watch to make sure groups are able to share tasks and ideas functionally. Having trays with prepared Brackitz pieces and exactly two wheels and axles will help.

Explain that constraints are limits on what we can use or make, and criteria is another design term that means "what counts as a success or a good design."

Reflection

5 minutes

"Getting feedback, or the thoughts of others, can make our designs better. Let's give two pieces of feedback for each group's three-wheeled design. I will model by saying, 'I really like this design because _____, and 'I wonder if one way to improve this vehicle could be _____.' Let's try using those sentences when we talk to others about their designs."

As you model giving feedback, make sure to ask what the group thought the design was for or where it could be used best. This will inform the students of what praise and suggestions make the most sense.

Preserve the three-wheeled vehicles for the final lesson in the unit, if you can.

CHALLENGE ADVANCED STUDENTS

In discussion, discuss how having an odd number of wheels (one or three) causes the designer to have to think about vehicle shape and balance differently than having two wheels.

In the group exploration, ask students if there is a specific advantage to having three wheels? Does it relate to the situations in which Gingerbread might use this vehicle?

In reflection, ask students if having a constraint is useful towards being creative. Ask them if thinking about their criteria is helpful before building.

SIMPLIFY FOR YOUNGER GROUPS

In discussion, help students predict that three wheels comes after two wheels if we're counting up. Show students specific examples of three-wheeled vehicles and direct them to notice some things three-wheeled vehicles may have in common: usually one wheel in front, two in back. Connect this design to how these vehicles are often used.

In the group exploration, show students pictures of their one-wheeled designs; ask if this gives them ideas on building something with three wheels. Show students their two-wheeled designs and ask if there was any drawback to two-wheeled vehicles. (Balance!) Can a third wheel help with that?

Name

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Student Worksheet

What are some three-wheeled vehicles you discussed in class today and how are they used?

Vehicle	Where or How it's Used

Write your own definition of what a "constraint" is when you're making or designing something:

Write your own definition of what "criteria" is when you're making or designing something:

Are three wheels better or worse than two wheels for vehicles? Explain your opinion:

Name

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Student Worksheet

What criteria or requirements should three-wheeled vehicles have to meet to be considered helpful and useful? List at least 2:

1. _____
2. _____
3. _____
4. _____

Draw your two-wheeled design here:

Where is the best place or situation to use this vehicle?

_____

_____

_____