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THREE WHEELS ON THE CART.:

LESSONS

WHEELS & AXELS

CREATIVE POWER
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4th & 5th grade
teacher plan

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:

Design, advantage, benefit, provide, mechanical advantage, request, specific, constraint, environment, exchange

Standards

NGSS 3-5 ETS1, ETS1.A, ETS1.B, ETS1.C, ETS1-1, 3-5 ETS1-2, 3-5 ETS1-2, PS3.C, LS1.A, 5-PS2

CCSS-Math MP2, MP3, MP6, MP7, MP8

CCSS-ELA SL.4.1, SL.5.1, SL.4.1c, SL.5.1c, SL.4.1d, SL.5.1d, CCRA.L1, CCRA.L.6, W.4.2, W.5.2, W.4.8, W.5.8

Time needed: 35-45 minutes

Materials and Supplies:

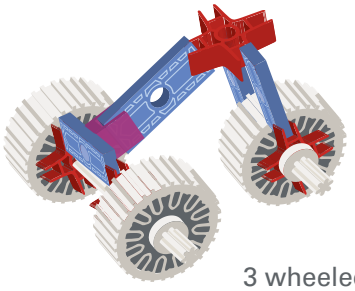
Paper, pencils/crayons, Brackitz planks (1x1 and 1x2), and 3 and 4-way hubs, as well 1-way pivoting hubs. Give out exactly three tires and axle-splines and lock washers to each group.

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.



3 wheeled example

brackitz connecting imaginations

Lesson 4: THREE WHEELS ON THE CART.

35-40 minutes

Whole Class — 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 can also be 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 — 10 minutes

"Today your design constraint is to have exactly three wheels. Design a three-wheeled vehicle. How will we know if your design is working successfully? Decide ahead of time what it needs to be able to do when you test it and where it needs to be able to go - **that's your criteria. "**

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!**

Pictures offered in this lesson are for instructor reference. Showing pictures to students at this stage may supply a solution without engaging them in discovery or creativity.

Try having students review their one and two-wheeled models. Ask them to discuss and sketch how they would modify them to make three-wheeled carts.

You can ask students to think about a place someone 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 toys out of the way to make something new, etc.) Then ask how three wheels can help us design something that 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 a small creature 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

"Do an idea exchange with the group next to you. Tell them one thing you like about their design and one idea for making it better. Then, they will give you the same feedback. 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."

Model giving feedback 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, make sure to ask what the group thought the design was for or where it could best be used. This will inform 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, compare and contrast with one-wheeled and two-wheeled vehicles. What are some similarities/differences with real-life uses.

In the group exploration, ask students if there is a specific advantage to having three wheels? Ask students to hypothesize why an odd number of wheels is less common that two or four wheels.

In reflection, ask students if having a constraint is useful towards being creative. Ask them if thinking about their criteria before building is helpful. Work as a class to agree on three criteria that make the most sense to test. Do any apply to vehicles with other numbers of wheels, or are these criteria special to three-wheeled vehicles?

SIMPLIFY FOR YOUNGER GROUPS

In discussion, ask, "When we had one wheel, where did it go? (Front or back?) And then how did the other side balance? (Holding an example of this may help students consider how three wheels are similar to one wheel, and also help them think about designing with this constraint.) 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

Name

Lesson 4: THREE WHEELS ON THE CART

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?

_____

_____

_____

What feedback did you get on your vehicle?

1. _____
2. _____
3. _____