Adapted to STEMAZing ECE Format by
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Loop-the-Loop and Other Explorations with Die Cast Cars

Materials (for four testing stations)
4 Name Brand Die Cast Cars (Hot Wheels™ or Matchbox™)
4 Generic Die Cast Cars
16 Hot Wheels™ Track Sections and Connectors
4 Hot Wheels™ Loop Accessory and Track Section
4 Hot Wheels™ Car Launcher with Connector and Short Track Section
Masking Tape

Key Question
How can we use data to determine which cars are better than others?

Learning Objectives
Children will…

- play with cars and tracks and launchers to become familiar with how they work.
- collect data and compare name brand vs. generic die cast cars successfully making through the loop-the-loop.
- consider their own experiments and collect data to compare cars from their own experiments.

Vocabulary (See **What the heck? Explanation of Science** at the end for definitions.)

Gravity	Name Brand	Work
Loop-the-Loop	Generic	Data
Die Cast Car	Energy	Friction

SAFETY CONCERN
- Watch out for young students using cars as projectiles instead of toy cars.

STEMAZing Teaching Philosophy

<u>Children should always be given ample time to experiment, notice, and wonder before they are provided an explanation.</u>

Always engage children with our two favorite questions:

What do you notice? What do you wonder?

Resist the urge to answer any questions children have while exploring. Instead, respond back with questions to children and let them make sense of the world. Sample questions you might use: What do you think? Do you notice any patterns? What could we change? Can we test something else? What can we try next? If children ask a testable question, which they could answer by doing an experiment, talk through with them how they might design a test to help answer their question. As much as possible and within reason, let them actually test their questions by trying the experiments they propose.

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Advanced Teacher Setup

1. Set up the four testing stations each with the following supplies:
    - One loop with two track lengths on one side and one on the other side of the loop.
    - Launcher with short track length.
    - One track length on its own. This can also be attached to the launcher when needed.
    - Two different styled cars – preferably one name brand and one generic.

Breaking Gender Stereotypes Introduction

1. Give young scientists 5-10 minutes to draw the picture of a racecar driver.

2. Next, show this video about the kind of toys 1st grade girls select when given an option and how we might change that. Don't mention what the video is about. Just play it.
    - **Mercedes-Benz x Matchbox: No Limits (http://bit.ly/MatchboxForGirls)**

3. Ask students to discuss what they saw in the video. You might prompt them with questions like:
    - Why do you think the girls in the video didn't pick the car to begin with?
    - Are there some toys only boys should be allowed to play with?
    - Are there some toys only girls should be allowed to play with?

4. Ask students if they would like to see the video they showed the girls about Ewy and then show it to them.
    - **Ewy Rosqvist: An Unexpected Champion (http://bit.ly/EwyRosqvist)**

5. Ask students to discuss what they just saw in the video about Ewy. You might prompt them with questions like:
    - What challenges did Ewy face?
    - Do girls race cars?
    - What is inspiring about Ewy's story?
    - How hard do you think Ewy worked to become a great car racer?

Notice and Wonder Developmentally Appropriate Practice

1. Let the young scientists play with the cars, track, loop, and launcher.
    - Make sure they play with simple ramps the cars go down and off the end of the track.
    - Make sure they play with cars going down a ramp and successfully loop-the-loop.
    - Make sure they figure out how to use the launcher to propel a car along the track.

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2. Help the young scientists compare the ramp height required for two cars to loop-the-loop – travel completely through the loop and remain on the track.
    - First, ask them what they had to do to get the car to loop-the-loop successfully.
    - Then, ask them what they think would be better – a car that can loop-the-loop when the ramp is lower versus a car that can loop-the-loop when the ramp is higher. Compare the higher height to needing more help and settle on better being the car that can loop-the-loop from the lower height.
    - Let the young scientists pick two cars they want to compare – preferably one that is a name brand car and one that is generic though this is not critically important.
    - With tape, mark 10 cm marks on the wall with masking tape. You can label these with their height – 10 cm, 20 cm, 30 cm, etc.
    - Ask the young scientists to think about what the data will look for all the possible outcomes of the experiment. They will make three hypotheses and think about what the data would look like.
        - Hypothesis 1: The name brand car is better at looping-the-loop than the generic car. (Data will show that name brand car starts from a lower ramp height than the generic car to successfully loop-the-loop.)
        - Hypothesis 2: The generic car is better at looping-the-loop than the name brand car. (Data will show that the generic car starts from a lower ramp than the name brand car to successfully loop-the-loop.)
        - Hypothesis 3: Neither car is better at looping-the-loop than the other one. (Data will show that they start from the same ramp height to successfully loop-the-loop.)
    - Let young scientists systematically test each car by starting with the end of the two track lengths before the ramp at the 10 cm mark on the wall. Show them how to line the car up at the top of the ramp and let it go. If the car does not loop-the-loop and make it through to the other side, they should try that ramp height a few more times. Then, when it is determined it really won't loop-the-loop from that starting ramp height, the young scientists should increase the ramp height 10 cm and try again.
        - A successful loop height is one at which the car can successfully loop-the-loop FIVE times in a row without missing.
    - Once they have found the successful ramp height for one car, they should put a piece of masking tape next to that height and the teacher can label it for them.

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- Then, they should test the other car to see which height it requires to successfully loop-the-loop FIVE times in a row. This should also be marked with a piece of masking tape.
- Once both data points are found, you can revisit the hypotheses with the young scientists and decide which one is supported by the evidence. (Avoid using the words "true", "prove", or "proven" when referencing the hypothesis. Instead, you should talk about how the evidence supports one of the hypotheses.)
  - Questions to ask young scientists about the data:
    - Did the cars both have the same ramp height to loop-the-loop FIVE times in a row? (If yes, then Hypothesis 3 is supported by their data.)
    - Which one needed the least amount of help (lower ramp height)?
    - Which one needed the most help (higher ramp height)?
    - So, which car is better (need the least amount of help – lowest ramp height)?

Children should notice…

- the cars go faster when they are released from a higher ramp height.
- the cars are different – different shapes, different sizes, different weights.
- the cars behave differently – one requires a higher ramp height than the other to successfully loop-the-loop.

Differentiating Developmentally Appropriate Practice

Older students will need less support with the setup of the ramp and testing.

Younger students may need more support from the teacher as they test out different ramp heights. The teacher make need to hold the ramp in place.

Extensions for Additional Learning

As always, ask the children throughout the experiment what they notice and what they wonder. If their wonder questions are testable, as much as possible and within reason, let them actually test their questions by trying new experiments.

See below for examples of what they might wonder and experiments they might do to test their wonderings.

- I wonder what would happen if we make the ramp height much higher than needed to make the loop?
  - Let them try it! Young scientists should make observations about what changes when they release the cars from a much higher ramp height.
- I wonder what would happen if we let the car go backward down the ramp?
  - Let them try it! For some cars, they perform better going backward vs. forward. Let young scientists make observations about any differences they notice and perhaps check the ramp height for successful loop trips going down the ramp forward vs. backward.

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- I wonder if we can use the launcher to get the cars to loop-the-loop successfully?
  - Let them try it!
- I wonder how far the cars will go off the end of a ramp on concrete? On carpet? On grass? Etc.
  - Let them try it! For data, they can let the go either go down a ramp of the same height each time or launch it off a track with the launcher. They can then see how far they go and mark data points with masking tape. They should try each car five times and see how the data points vary a little bit each time. You can also have young scientists make hypotheses about which surface the car will travel the furthest on. In this case, make sure to test just two different surfaces like concrete vs. carpet or a rug. Then they will have three possible hypotheses like before:
    - Hypothesis 1: The car will go further on the carpet than on the concrete.
    - Hypothesis 2: The car will go further on the concrete than on the carpet.
    - Hypothesis 3: The car will go about the same distance on both concrete and carpet.
- I wonder if the car will work better with more weight added to it?
  - Let them try it! They can tape pennies or paper clips to the top of the car to increase its weight. They can then retest it either down a ramp and how far it goes or successfully completing the loop five times in a row to see if it has changed.
- I wonder if we can get a car to go over two loops?
  - Let them try it! Let them set up a track and see if there is a ramp height that will let the car travel through two loops FIVE times in a row.

#STEMAZingPictureBook Recommendation:

Baby Loves Gravity! by Ruth Spiro – learn and discuss more about gravity with young scientists.

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AZ Early Learning Standards

Above and beyond the Social Emotional, Approaches to Learning, Language and Literacy, Social Studies, and Physical Development, Health, & Safety Standards which may naturally apply to the lesson, the following Science, Math, and Fine Arts Standards are strongly connected to this lesson:

Science Standard – Strand 1: Inquiry & Application

Concept 1: Exploration, Observation & Hypotheses – The child observes, explore, and interacts with materials, others, and the environment.

Concept 2: Investigation – The child researches their own predictions and the ideas of others through active exploration and experimentation.

Concept 3: Analysis and Conclusion – The child analyzes data (their observations and background knowledge) and forms conclusions about their investigation.

Concept 4: Communication – The child discusses, communicates, and reflects upon the scientific investigation and its findings.

Math Standard – Strand 1: Counting & Cardinality

Concept 4: Counts to Tell Number of Objects – The child uses number words and counting to identify quantity.

Math Standard – Strand 3: Measurement and Data

Concept 2: Data Analysis – With prompting and support the child collects, organizes, displays, and describes relevant data.

Concept 3: Measures – The child uses measurement to describe and compare objects in the environment.

Loop-the-Loop and Other Explorations with Die Cast Cars

What the heck? Explanation of the Science (Vocabulary in bold.)

The young scientists do **work** to lift the car up against gravity and place it on top of the elevated ramp. (You can make lifting the car up dramatic, like it is difficult though it is really quite easy, to demonstrate that they are working against gravity to lift the car up.) **Gravity** is an attraction between objects that have mass. All things on Earth's surface are affected by Earth's gravity because Earth has a huge mass. This means Earth will pull things back down toward its surface when they are lifted away from it.

In doing work to lift the car up against gravity, it now has stored potential **energy**. When the car is released on the ramp from this elevated height, the potential energy turns into kinetic energy. The work done to lift the car is now transferred to making the car move. The higher you lift it up to give it more potential energy, the faster it will be moving when it gets to the bottom of the ramp because it will have more kinetic energy. You can compare this to young scientists eating food (taking in potential energy) so they have the energy to run around (kinetic energy).

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A **die cast car** is a metal toy car made by pouring metal into a cast or mold to form the car. Historical note, Matchbox™ cars started off as a toy for a young girl to bring to show-and-tell when the rule her teacher gave was that whatever you brought in would have to fit inside a matchbox. So, her dad made her a car that would fit inside a matchbox and she took it in for show-and-tell. From there, Matchbox™ cars were born. Learn more about the history of Matchbox™ cars here: https://bit.ly/MatchboxCarStory
Name brands are the brands of die cast cars made by big toy companies. Name brands for die cast cars include Hot Wheels™ and Matchbox™. You can also find **generic** die cast cars made by manufacturers worried about them being cheaper and not as fancy in their design, generally.

When doing any experiment, data is used to come to a conclusion about the result. In the original experiment, the car is tested to see what ramp height is needed to successfully loop-the-loop. **Loop-the-loop** was originally used to describe an airplane maneuver where the pilot would loop the airplane in a vertical circle in the sky. It is now used as a term for any amusement park rides that sends passengers in a complete 360 degree loop. **Data** are the measurements made in an experiment to compare results. The data for the experiment is the ramp height at which each car successfully loops-the-loop. In other experiments, like rolling the car down a ramp to see how far it will travel along concrete vs. carpet, the data are the distances the car travels in its five trials or attempts. In this case, the data would be quantitative. Observational data – noticing various similarities and differences during experiments using your senses – is also very helpful data to collect.

In order for the car to successfully loop-the-loop, it must have enough kinetic energy at the bottom of the ramp to carry it up the loop, doing work against gravity to keep it connected to the track all the way through the top and around the other side. If the car is not going fast enough when it enters the loop and starts to work against gravity, gravity will win and pull the car down off the track and making it crash.

Looping-the-loop has been done in real life. You can see a short 4:22 minute documentary by Hot Wheels™ called Double Loop Dare here:
https://bit.ly/HotWheelsDoubleLoopDare

In an experiment testing how far the cars will go on different surfaces, like concrete vs. carpet, friction is coming into play. In general, the rougher the surface the higher the friction. **Friction** is a force created with two things are trying to slide past one another and it is created by the, often microscopic, roughness of the surfaces. For the concrete and carpet, it is easy to see that one is smoother (concrete) than the other (carpet). So, the carpet will have higher friction than the concrete. The higher the friction, the more force the car will experience to slow it down. So, this means the car should travel further on the concrete than on the carpet. Be sure to let the data support whatever it supports. For instance, if the data show that the car travels further on the carpet than the concrete, it is okay to show surprise at that finding because you didn't expect it. It is not okay, to change the data or keep redoing the experiment until the data supports what you think should happen.