Miniature Golf Tournament

Grade Range: Middle School **Lesson Time: 3 class periods**

Key Terms
Elastic collisions Kinetic energy Par Potential energy Slope Trajectory

Materials and Resources	
Putters and golf balls Modeling clay Corrugated cardboard cut into 6-inch-wide strips Bendable board or cardboard Cardboard or PVC tubes wide enough for golf balls to roll through Masking tape Small objects to use as hazards: soda cans, cereal boxes, carpet squares, etc.	Camera (optional) Expert: Golf pro zSpace Newton's Park Internet access *Guide to Designing Your Miniature Golf Course* Worksheet

Activity Overview

Miniature golf is not only fun, it's a great way to apply the laws of physics and the principles of mathematics. Just imagine what it would have been like to play a round of miniature golf with Sir Isaac Newton! The students will work in teams to design and build a real miniature golf course in the classroom. Once students complete the task, they will apply insights from the project to "take it to the next level" and build the same course in Newton's Park.

The goal of this project-based learning activity is to give students an opportunity to build a miniature golf hole in the classroom and create the same design task in zSpace. As students observe what makes a real golf hole "easy" or "hard," it will inform their golf course designs. The zSpace experience enables students to systematically conduct repeatable tests changing different variables such as gravity, the mass of the golf ball, and the force exerted on the ball. It also makes it possible to slow down time, freeze motion, and even display the path of a ball as it rolls across the plane. Compared to simply playing a game of real miniature golf, these insights will greatly enhance student learning! The project features a high-energy "tournament" in which students demonstrate their learning.

Essential Questions

1. How does force affect the motion of an object?
2. What is the relationship among force, mass, and acceleration?

Objectives

- Using the laws of physics create, test, and evaluate a miniature golf hole
- Use math principles to design triangular and curved ramps that can be built using cardboard and tape
- Use Newton's Park to build a simulation of each team's physical golf hole
- Develop presentation skills

Part 1: Building the Course

Teacher Tips: Try to use supplies that are similar to the ones in Newton's Park. This project can be done on a tabletop scale if needed, but larger spaces will allow more learning. Depending on the space available, each team may have four to eight feet of length for their hole. Going outdoors on the lawn or asphalt is a good option. Using "wiffle" balls instead of golf balls may be helpful if the course is small.

Organize the class into 9 groups. Each group will be responsible for building one miniature golf hole. Each group will conduct research on how to build a miniature golf hole, design a golf hole, build and test the golf hole. When students complete the task, ask them to evaluate the design product as well as their final product.

Optional: Have students record their golf hole being played and combine the videos to create a movie of the whole course being played.

See the *Guide to Designing Your Miniature Golf Course* worksheet for Student Course Design Instructions.

Part 2: Creating the Virtual Course - zSpace

Students will open the *Miniature Golf Tournament* activity in Newton's Park (activity questions and answers below). After getting comfortable with Newton's Park through the activity, they will work to re-create their real-world miniature golf course using the supplies in Newton's Park. If the supplies are not the same as in their in-class model, the students will need to create a new golf hole in zSpace. Once the students have designed the golf hole, they will launch the experiment to see if the soccer ball reaches the hole. If it does not, students need to make adjustments to their design. If it does, instruct the students to change different variables (gravity, mass, force) in Newton's Park to observe how those changes affect the final outcome.

Extension: have students attempt their golf hole on different planets or with balls of different mass.
Optional: Create a class video of the course by combining a movie of each hole being played. Use the zSpace Newton's Park Tutorial to help students learn how to make videos of their experiment in Newton's Park.

Introduction: Now that you have played some real golf, it is time to create a virtual course! See how closely you can model the hole you designed in the real world when you are working in Newton's Park. When you are done, invite other teams to come and try it.

Activity Questions Provided in *Miniature Golf Tournament* in Newton's Park

1. The soccer ball in this scene needs to make it from the end of the launcher into the putting cup. Design and build a solution to get the ball to its target using no more than 10 materials from the Backpack. Take a photo of your successful design.
   Photo.
2. What were some of the problems you had, and how did you work around them? Write about the things you tried that did not work. What did you learn from your failures? Describe your experience.
   Yes, when I originally built my solution the angles of the deflectors were not correct and the ball did not reach the putting cup. I corrected my error and the ball reached the putting cup.

3. Now that you have conquered this challenge, take a close look at your design. Can you see any ways to make it simpler? Engineers call this process "value engineering." They like to design things that are both simple and effective! Describe some changes you could test which might reduce the number of parts used or simplify your design in other ways.
   I found one deflector I did not really need. Also, if the deflectors were all the the same size instead of different sizes, it would make my golf hole easier to build.

Closing

When the zSpace golf activity is done, bring students together to share insights about the science and math concepts they learned. Ask each team to make a brief presentation in which they share one or two interesting aspects of their design, report on their results, and comment on how what they observed ties to what was learned earlier using the zSpace tools.

Questions for Discussion

1. How well were you able to simulate your original golf hole?
   Not very well at first. It took a lot of test runs and adjustments to finally simulate the golf hole.
2. How were you able to improve it using virtual reality (for example, by changing gravity, adding more features, etc.)?
   I was able to improve upon it by changing the materials of the platforms and balls.
3. What were some challenges you encountered?
   The biggest challenge was designing the tricky feature because we did not want it to be too easy or too tricky.
4. What new insights did you gain by using the tools of zSpace to replay the action, trace the course of the ball, measure forces, etc.?
   Replaying the action gave me another opportunity to see how I could improve upon my golf hole.

Extension Activity: Students could do the activity *Energy Skee Ball* in Newton's Park to learn more about different forms of energy

Follow-up Activity: *Putting Green Challenge* - Newton's Park

Differentiation

- Organize the students into teams with diverse skills and learning abilities; mix social groups to encourage healthy competition
- Create a vocabulary wall or other visual aid to help students see the connection between new terms and the objects/actions they represent
- Have students share their finished product using a presentation
- Plan ahead and make accommodations for children with special needs or physical impairments; be sure everyone is able to participate!
- Enrichment: Build in a math component by having teams figure out how long the top of a curved ramp will be (chord calculation)
- Enrichment: Students could add one moving hazard to the course

Resources

Art-inspired mini-golf course at a modern art museum
http://www.walkerart.org/magazine/2013/artist-designed-mini-golf-walker-on-the-green

http://legacy.kare11.com/story/news/local/2015/05/22/mini-golf-meets-modern-art-at-walker-art-center/27794093/

Miniature Golf PBS “Moment of Science”: https://www.youtube.com/watch?v=GygGhvcAaPw&noredirect=1

“Physics of Everything” video on mini-golf: https://www.youtube.com/watch?v=cWOiDI7gJFs

Photos for Inspiration

Add a teeter-totter!

http://www.miniaturegolf-build.info/obst2a.jpg

Add an obstacle, like a binder tunnel.

http://farm4.staticflickr.com/3060/2444442290_6dbe7232de_z.jpg

Add short lengths of tube or pipe.

http://www.dailyherald.com/storyimage/DA/20140813/entlife/140819796/EP/1/6/EP-140819796.jpg&updated=201408121349&MaxW=800&maxH=800&updated=201408121349&noborder

Other ideas:

http://media-cache-ec0.pinimg.com/736x/db/8b/39/db8b3955ea7f47966f8703c84671422f.jpg