Centrifugal Force and Mandy Sue Day
4th Grade

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References:

- Karim, Roberta. *Mandy Sue Day*, printed in Signatures; Harcourt Brace: Orlando, 1999.
- CAPtivating Science, part of Ohio Statewide Science Workshop; COSI: Ohio's center of Science and Industry, 1996.

Benchmarks:

SLC/GLI #: 4th grade: PS-4.

Objectives:

This lesson is a fun, interactive lesson to follow along with the story, Mandy Sue Day, which is part of the 4th grade reading curriculum. Centrifugal force is mentioned in this book, and as integrating science across the curriculum is one aim of the Columbus School District, Mrs. Skopin and I thought this would be a good way to do that. Other objectives of the lesson involve helping students understand what a force is and teaching them to be aware of centrifugal force, since it is one that they invariably experience nearly every day of their life. Thus, this lesson is great at helping students become aware of the continued presence of science in the common surroundings of every-day life. Finally, it is also the objective of this lesson to help students learn analytic thinking and the scientific method of asking a question, conducting an experiment, and making observations to try to answer the question.

This lesson will begin with the demonstration of centrifugal force that was used in Mandy Sue Day. The students will then get to experiment with same idea on a smaller scale, using bottle caps and confetti, instead of a bucket and water. Next, the students will get a chance to feel centrifugal force for themselves, either on the merry-go-round or with a partner, spinning in circles, discussing safety first. We will then discuss what they felt while doing this and ask some of the same questions as with the bottles caps, such as whether the speed matters. Finally, we will talk at a basic lever about what forces are and that what they are experiencing is centrifugal force, just like the water in the bucket.

Materials:

- Bucket and rope
- Bottle caps
- String
- Scissors
- Tape
- Water
- Confetti

- Lots of space to spread out

Initial Demonstration:

The demonstration for the beginning of this lesson involves the bucket, rope, and water. Tie the rope around the handle of the bucket. Fill the bucket part way (1/4 – ½ full depending on personal preference). Fill the bucket in front of students so they can actually see you put water in there. Also, possibly walk around the room with bucket and slosh the water around so that the students can see that it could spill out. Now, start asking the students questions about the water spilling out if you turn the bucket upside down, and if any of them know of a way to turn the bucket upside down or to the side with out the water spilling. Once they come up with inferences, actually spin the bucket in a circle, either upside down and/or straight out to the side. Ask the students what they think is going on and why the water didn't fall out. Also relate it to driving in a car and the feeling they get when their parents turn a corner. Include other experiences, if possible, such as amusement park rides, riding the merry-go-round, holding onto a friend's hands and spinning, etc.

Target Observations:

- Students should notice that the water doesn't fall out of the bucket if it's spinning while it's upside down, but it does fall out when you just tip it over.

Procedure:

1. Cut two pieces of string of the same length, at least 20 inches long.
2. Tape the center of each string to the flat side of th bottle cap so they form an X.
3. Tie all the ends of the strings into one knot, and hold so that inside of bottle cap faces the knot and bottle cap is swinging from string. (If time constraints exist, bottle caps may be prepared as is steps 1-3 by teacher before lesson begins.)
4. Fill the bottle cap half way with confetti.
5. Whirl the bottle cap in a circle up over your head.
6. Compare whirling the bottle cap with a quick motion immediately going to whirling it in a circle to rocking it back and forth, like a pendulum, before and after you whirl it.
7. Try spinning it at different speeds.
8. Write down any observations and answer questions on worksheet.
9. Ask them how this relates to Mandy Sue Day, and based on that do they know what this is called? Do they know what a force is?
10. Discuss idea of a force – a push or pull, and what centrifugal force is.

Target Observations:

- The students should notice that when whirling the confetti quickly over their head, none of it falls out of the bottle cap.
- If the students start the circular motion too slowly, or if they don't spin it fast enough, the confetti will fall out.

- If you use the pendulum motion at the end, as they're stopping the bottle cap, more of the confetti stays in the cap, as compared to just stopping outright.

Target Revised Model:

- Students should reach the conclusion that it is the act of spinning that causes the confetti or water not to fall out of the bottle cap
- They should also reach the conclusion (hopefully) that something is pushing/pulling the water/confetti against the bottom of the bottle cap.
- Finally, after force discussion, they should know that a force is a push or pull and that centrifugal force pushes the water/confetti outward against the bottom and walls of the bucket when its spinning, and that's why it doesn't spill.

Procedure:

If using merry-go-round:

1. Let a few students get on at a time.
2. Push them slowly, asking them what they feel.
3. Increase their speed, asking them what's different about going faster.
4. Now ask them how this relates to Mandy Sue Day.
5. See if they can relate what they feel to what happened with the water/confetti and bucket/bottle cap. Do they think the water was experiencing the same sensation?
6. Talk a little more about centrifugal force now that they had a chance to feel it.

If using partners spinning each other:

1. Have the students select partners, or put them in groups of two.
2. Discuss the safety and the importance of not letting go of each other while spinning.
3. Have the students hold hands with their partners while facing each other with their arms straight out in front of them.
4. Tell them to start spinning slowly, and ask them if they feel anything.
5. Tell them to speed up and see how that's different.

6-8. See merry-go-round steps 4-6.

Target Observations:

- Students should notice that when they spin they feel like their being pushed outward.
- Students should also notice that the feeling is stronger when they're moving faster.

Target Revised Model:

- They should reach the conclusion that something feels like it's pushing them outward.
- They should also recognize that this is a feeling that they feel often in every day life, such as in the car.
- They should be able to tell you that this feeling of being pushed outward is being caused by centrifugal force.

Summary:

This lesson was created so that students could learn what centrifugal force and to integrate science in with the reading curriculum. In this lesson, students will be able to recreate what Mandy Sue experienced in the story they read, and then experience the feel of centrifugal force themselves. They should learn that a force is a push or pull and that centrifugal force is a force that they experience in everyday life (turning a corner in a car) and causes objects to be pushed outward when traveling in a circle (or part of a circle, as when making a turn in a car). Although as a physicist, I know that centrifugal force is technically a fictitious force resulting from a combination of inertia and centripetal force in a rotating reference frame, if I teach it this way at that level, I believe I will only confuse the students.