NASCAR Racing and Forces and Motion

Cynthia Baker Woolery

Introduction

Elizabeth Traditional Elementary School (ETES) is an institution that has provided educational training for young children since opening its doors in 1912. This year we will celebrate one hundred years of serving the community. Our school has been a traditional K-5 magnet program since 1977. The school's building structures, name, and curriculum have been altered over the years to meet various demands on a diverse and ever-shifting population. One quality of the school and its staff has remained constant: Its commitment to a solid educational foundation for all students.

ETES is located near downtown Charlotte, North Carolina in the urban school district of the Charlotte/Mecklenburg School System, which is the eighteenth largest school district in the nation. The school serves five hundred and fifty students with the majority (fifty-seven percent) of the population being Africana American. Thirty-four percent of our students fall into the economically disadvantaged category.

I am beginning my second year as a full time Science Facilitator at this school. I have followed in the footsteps of an outstanding Science Facilitator who has worked many years at establishing a material rich lab and an outstanding reputation for hands-on science learning. I am fortunate that the PTA at my school understands that there is a cost to running a Science Lab and therefore collects a Science Lab fee from each students family that is able to give. The generous budget helps me to obtain supplies as needed, pays for feed and upkeep of the lab animals and attain new technology.

When I arrived at the school I arranged the lab to have five tables for group experiments and cooperative working groups as well as a Media Viewing Space (rugged area where a computer, smart board, ladybug document camera, and digital microscope are located). I also have a demonstration table, a distribution table and mini computer lab with four computers set up for research. The demonstration table is where I teach correct handling of scientific tools, demonstrate experiments that can be viewed through the document camera onto the Smart board, and serves as the designated messy space because it is easily cleaned up. The distribution table is used for students to pick up and return the materials needed for their particular lab.

The Science Lab experience is considered "Special" on the same level as Media Center, Art, Music, P. E. and Math/Computer classes. Every student in the school comes to the Science Lab rotating on a four day schedule. Daily I teach one class from each grade level a fifty minute lesson with a five minute transition window in between classes.

This year my curriculum switched from the North Carolina Standard Course of Study to the new North Carolina State Essential Standards and Common Core Standards. For the purpose of this curriculum unit I will address the first of seven essential standards as outlined in the new Essential Standards for fifth grade. I will teach Forces and Motion through the standard **of** understanding force, motion and the relationship between them. The clarifying objectives for this standard are: Explain how factors such as gravity, friction, and change in mass affect the motion of objects, infer the motion of objects in terms of how far they travel in a certain amount of time and the direction in which they travel, illustrate the motion of an object using a graph to show a change in position over a period of time. Predict the effect of a given force or a change in mass on the motion of an object.

Comment [pt1]: This is the first time you state what you are going to do. This seems like a pretty important statement to bury in the document. Consider pulling it out as a bold one line paragraph.

For most lessons I use the Five E's (*Explore, Engage, Explain, Elaborate, and Evaluate)* in planning interactive lessons. I have discovered many excellent interactive science web sites where students can perform virtual experiments. Viewing videos from these web sites as a group has had a real impact on student learning. Many of my students are lacking in life experiences, science vocabulary and previous experience in drawings, models, charts and graphs to communicate results and explanations. The use of the computer gives them background knowledge to be able perform their own discovery experiments.

Rationale

The state of North Carolina has elevated the fifth grade Science test as a "gate-way" test. The Science end of grade (EOG) test has been placed on the same level as Reading and Math EOG's. Schools are often judged by the public, parents, teachers and others on how the students score on the EOG's. This year our students will take a new Science EOG which will serve as a baseline for years to come. The test will cover the NC Essential Standards (several of which are new to both students and teachers). Once this baseline is established the results will be used to help determine teacher evaluations. These facts have had a great impact on the teaching of Science at the elementary level. Testing our students in science and being held accountable for their growth is stretching our teaching of science!

During the first quarter of fifth grade I am assigned to teach Forces and Motion (see appendices one for full standards). For the last few years of teaching this subject I have taught Forces and Motion by the use of videos from Discovery Education, hands on activities, and a few experiments. This has been marginally successful. As a reflective teacher I was searching for a way to study this standard in a highly motivational way.

Dr. Peter Tkacik, Assistant Professor of Motorsports at the University of North Carolina at Charlotte, and I discussed looking at the topic through the lens of the sport of NASCAR. I want my students to first be enthusiastic about understand the basics of forces and motion and the accompanied vocabulary by the study of a local event- NASCAR racing.

Student Activities

We will look at the role gravity, friction and change in mass affect the cars and the great detail drivers and their teams go through to have the most efficient cars. We will use actual statistics to graph the speed of the cars. Each cooperative learning group will pick a driver and car to become an “expert” on. The students will then create their own cars and test them for distance, speed and their ability to have their cars come to a stop in a designated space.

Students’ strategies for finding solutions to questions improve as they gain experience conducting simple investigations and working in small groups. The students will be encouraged to ask questions and make predictions that can be tested. During the investigations, students will have opportunity to use tools such as calculators, computers, scales and meter sticks to gather data. They will keep accurate records in their science journals and run enough trials to be confident of their results to test a prediction. The goal is to make this subject come alive to my students and let them see practical usage and real world application of the concepts of forces and motion.

Instructional Content

History of NASCAR

NASCAR’s roots go back to Prohibition when runners (people who delivered moonshine), fixed up their cars so they could out run the federal tax agents determined to bust them. Occasionally the drivers would hold informal races to determine which car was the fastest. In the late 1940s, those contests had become an organized sport, largely due to the efforts of one driver, Big Bill France. Big Bill organized a meeting of drivers, car owners and mechanics at the Streamline Hotel in Daytona Beach, Fla., on December 14, 1947, to discuss the problems facing stock-car racing and to establish standard rules for racing. There and then the National Association for Stock Car Auto Racing (NASCAR) was conceived. Two months later, on February 15, 1948, the first official NASCAR race was held on the beach in Daytona. A week later, NASCAR was incorporated, and Big Bill appointed as its leader.

In 1949, the premier racing division in America, (now the Cup Series) was created. There are now three divisions of NASCAR. The NASCAR Sprint Cup, Nationwide Series and Camping World Truck Series

The first ever NASCAR Grand National (now Sprint Cup) event was held at the Charlotte (N.C.) Fairgrounds on June 19, 1949. Ten years later (1959) the 1.5 quad-oval Charlotte Motor Speedway was completed. Our speedway can seat 165,000 happy fans!

Vocabulary

The teaching of vocabulary is the job of all teachers. While inquiry skills, concept development, and understanding are the main goals, students knowing and using key vocabulary are important outcomes of science education**.**

Science texts contain many new words that students are expected to learn from reading. These words represent important ideas and concepts that are central to science understanding. However, learning new words encountered in text can be a difficult task for young students. It is therefore our duty to provide successful instruction with on conceptually important words that are essential for understanding broad ideas in the unit of forces and motion.

The following vocabulary words are words that educators should master, integrate and be able to conceptualize before they begin teaching this unit. I have used "kid friendly" language in defining the words so that it can be used as a quick reference as this curriculum unit is taught.

- The **position** of an object is the location of an object. If the position of the object changes you will know it has moved by the objects relationship to its surroundings. An example of position would be car 49 was behind car 29, then car 49 passed car 29. The position of car 49 has changed.
- **Distance** is the length of the path traveled between two places. For example, at the Bank of America 500 (the Charlotte race), the cars race for a distance of 500 miles.
- **Displacement** is the length between two places. When an object moves it goes from starting position to an ending position. Measuring the length (path taken) between the starting and ending positions gives you distance. Measuring the straight length between the starting and ending positions gives you the displacement. In race cars, the engine size is called displacement and is the displaced volume of the pistons. It is piston area times the number of pistons times the stroke length and all Sprint Cup cars have a 358 cubic inch engine.
- **Motion** is a change in position. Many of my students stay in motion! When the cars travel around the track position they are in motion.
- **Speed** is how fast an object moves over a certain distance. To measure speed you need to measure time and distance. The distance an object travels in a

period of time tells you the speed. An equation to use is speed equals distance divide by time. NASCAR race cars often top 200 miles per hour!

- **Velocity** is the rate of motion (speed) in a specific direction.
- **Forces** are all around us and can change an object's motion. A force is a push or a pull. When forces are equal, or balanced there is no change in motion. Unequal forces cause a change in motion. Change in motion occurs when an object starts moving or stops moving, speeds up, slows down or changes direction.
- **Mass** is defined as the measure of the amount of "stuff" in something. The more mass something has, the harder it is to move or, the more sluggish it is. If we were on the moon our mass would be the same, but our weight will have changed.
- **Gravity** is a force which tries to pull two objects toward each other. Anything which has mass also has a gravitational pull. The more massive an object is, and the closer it is, the stronger it's gravitational pull. Since force equals mass times acceleration, gravity is often referred to as acceleration. On earth, gravity is an acceleration of 32.2 feet per second squared, (9.81 m/s**2).
- **Acceleration** is the rate of change in velocity. You speed up if the acceleration and velocity point in the same direction. You slow down (also referred to as decelerating) if the acceleration and velocity point in opposite directions. When you accelerate or decelerate, (or even go around a turn), you change your velocity by a specific amount over a specific amount of time. In race cars, acceleration is often referred to as a multiple of (gravity) G's. That is, a race car may accelerate or corner at two g's. Formula one drivers often corner at five g's and can look like a pin ball bouncing back and forth through the turns.
- **Weight** is how much pull gravity has on an object. Gravity is what gives you weight. Because the moon has much less gravitational pull, I would weigh one sixth as much on the moon!
- **Friction** is the force that occurs when two objects rub against each other. Different materials produce different amounts of friction. Smooth pavement produces very high friction while a gravel road creates much less friction (try stopping fast on a gravel road). Friction slows things down, heats things up and wears things out.
- **Momentum** can be defined as "mass in motion." All objects have mass; so if an object is moving, then it has momentum. The amount of momentum that an object has is dependent upon two variables: how much stuff is moving and how fast the stuff is moving. In terms of an equation, the momentum of an object is equal to the mass of the object times the velocity of the object. A NASCAR race car that weighs 3600 and travelling at 200 mph has 720,000 lb.*miles per

hour (708,000 kg*m/s). A ten pound bowling ball moving at 1 mile an hour has as much momentum, or striking force, as a five pound bowling ball moving at 2 miles an hour.

- **Draft** is the aerodynamic effect that when a car pushes through the air at speed, it pulls suction behind it.
- **Drafting** is the practice of two or more cars, while racing, to run nose-to-tail, almost touching. The lead car, by displacing the air in front of it, creates a vacuum behind it and somewhat pulls the second car along with it. With so little air pushing through its radiator, the following car may even overheat.
- **Drag** is the wind resistance a car experiences when passing through air at high speeds. A resisting force exerted on a car parallel to its air stream and opposite in direction to its motion. At full speed, only 15 horsepower is needed to spin the car parts but over 800 hp are needed to push the air aside.

Newton's Laws

Now that we have explored some of the vocabulary of forces and motion I turn to Sir Isaac Newton, a physicist, mathematician, astronomer and philosopher who lived over 300 years ago. Newton gave us three laws to explain the properties of motion. As teachers we must understand the laws and apply them to our teaching. The **first law** states that an object at rest tends to stay at rest, and an object in motion tends to stay in motion, with the same direction and speed. Motion (or lack of motion) cannot change without an unbalanced force acting upon it.

The **second law** says that the acceleration of an object produced by a net (total) applied force is directly related to the magnitude of the force, the same direction as the force, and inversely related to the mass of the object. The second law shows that if you exert the same force on two objects of different mass, you will get different accelerations. The effect (acceleration) on the smaller mass will be greater.

The **third law** says that for every action (force) there is an equal and opposite reaction (force). Forces are found in pairs. Two objects are always involved in reaction. One body can never exert a force upon another one without the second reacting against the first.

Strategies

The first strategy is to bring my students to a basic understanding of forces and motion as it pertains to NASCAR. I will start with my students own questions and personal curiosity about the sport, their ideas of how to make a car a winner, and how/why we are using NASCAR to teach science**.** The questions they formulate as they contemplate the forces and motion of the sport will be used to guide the unit.

The second strategy is to help my students to understand the study forces and motion through hands-on experiments where they use the knowledge gained from studying NASCAR **to** design and create their own car. They will **r**ace their cars then have a chance to improve them through redesign**.**

The third strategy will be for the student to select a project to show what knowledge ~~thay~~they have gained about Forces and Motion. My fifth grade student will then share their project with younger students.

Classroom Activities

Students will make and maintain a Forces and Motion Journal. In this journal they will record what they have learned, what they want to learn more about, and vocabulary. They will also record their answers to questions such as:

- When have you made something move?
- How can you make objects (like a toy car) go farther and faster?
- What forces are acting on a car as it travels a race track?
- Does the surface of the track make a difference?

The materials needed for the main activity for this unit are; a track on an inclined plane (appendices two), race cars made from recycled materials, meter tape and a balance scale with gram weights.

Design and Build a Race Car

This activity will span five fifty-five minute time periods. Students will be asked to design a race car that will fit on the track using recycled materials only. The NASCAR theme should be kept in mind as they create their numbered cars. Some students may even want to seek out sponsors! Students will work in cooperating groups of two or three and each will have an assigned task for each of the four events. Task can include, but are not limited to; driver, pit crew member, official (measures and records).

Pre-Race Activity Day

The first event will be our Pre-Race Activity Day. Students will register their cars by identifying their cars by number, name of driver and crew members. They will use the balance scale to find the mass of their cars and measure height and length of the car in centimeters. They will look at the four performance tasks and will write down the role and job description of each person on the "Team". Each Team will then proceed to the track and test their cars by placing their car on the designated points (A, B, C, and D) and releasing the car from that starting point on the inclined plane. Students will measure and record distance from this point to the front wheel position of the car at rest. Each car will be released a total of three times from each point on the inclined plane. This procedure will be repeated from points B, C, and D on the inclined plane. Students will then analyze this data.

“Pit Stop”

The second event will be called the “Pit Stop”. During this activity the students will use the data to make a decision as to where to place their car on the ramp (inclined plane) in order for the car to come to a stop inside of the “pit”. The pit will be a designated space that the teacher marks on the surface passed the ramp. Students must decide where to release their car on the ramp in order for it to come to rest inside of the pit area. If the car stops entirely inside the pit area the team is awarded 100 points, if the car comes to rest with some part of the car inside the pit the team earns 75 points. If the car stops within 2 centimeters of the pit they will receive 50 points and if the car is more than 2 and less than 4 centimeters from the pit they will earn 25 points. Each team will have a total of 3 trials with the best trial giving the points for this event. Students will write in their journals how and why they made changes to their trial runs and will diagram the event.

“High on the Hill”

The third event is called “High on the Hill.” In this event the driver and pit crew will decided where to place their car on the ramp so that their car will come to rest on top of a hill that has been placed near the end of the ramp. If the car is traveling to slow when it comes to the hill it will not be able to make it to the top, but if the car is traveling to fast it will go down the other side of the hill. Students will release their cars from any point on the ramp and will have four trials to get the car to stop on the top. If the car comes to a stop at the top of the hill on the first trial the team will earn one hundred fifty points. The team will earn one hundred points if they accomplish the task on the second try and fifty points if they achieve the goal on the third trial and twenty-five points if they need all four trials to get the car to stop on the hill. When they have finished they will write in their journals how and what they did to accomplish this event or what they could have done differently. They will diagram the event and record their earned points.

“Cliff Hanger”

The fourth event is called “Cliff Hanger” This event will take place on top of a long table with the table ending three meters from the end of the ramp. In this event students will be able to release their cars from any point on the ramp with the goal of stopping as close to the edge of the “cliff” as possible with going over! If any part of the car comes within three centimeters of the cliff the team is awarded 150 points. If the car comes to rest more than three centimeters from the cliff, but less than six centimeters from going over, then the team will receive 100 points. If car is more than six centimeters but less than nine centimeters then the team will be awarded 50 points. Unfortunately, if the car goes over the cliff and crashes the team will need to subtract twenty points.

Student Choice

The fifth event will be student choice. They can enter their cars either in a “Demolition Derby” or a “Cruise In, Car Show”. They also will be able to modify/ redesign their cars for this finial event.

In the Demolition Derby a car will be placed on the ramp and run into a barrier at one meter. If the car is not disabled the barrier will be moved to fifty mille-meters and the car will have a second run. If the car withstands the second crash we will move the barrier to the end of the ramp. A car will be classified disabled when it cannot be rolled. Twenty-five points will be awarded if the car can be rolled after the first trial. (Teachers Note: I wonder if any of my students will start their cars at the bottom of the ramp to insure success.) Fifty points will be awarded to cars that roll after the second trial while 100 points will be awarded to the cars that can roll after crashing into the barrier at the end of the ramp.

The media specialist has agreed to host our Cruise In, Car Show. The cars will be set up in the media center and each of our students will have a “cruise” through the show to look at each car. After careful consideration of how each car looks they will be given a paperclip and asked to deposit the paperclip in a container in front of the car they would like to vote for. At the end of each day I will count the “votes”. A point will be added to the teams score for every vote they receive at the Cruise In, Car Show. Hopefully this will get the students excited and thinking ahead to when they will become my fifth grade NASCAR students!

The students will again write in their journals. They will write about their choice to enter the Demolition Derby or the Cruise In and share their reasons for their choice. They will also share if they choose to modify their cars and exactly how they modified them. They will share strategies they used to have their car become the best car possible for the task.

At the end of these events students will use a tally sheet (see appendices three) and turn in their total performance score. The top five teams will be awarded “Checkered Flag” award and all teams will be given a participation award.

As a celebration I will contact the Charlotte Motor Speedway and see if a racer (legend) driver will come to speak to our students. If a race car driver is not available we could Skype our questions to him. I will ask if one of the cars can be brought to the school for students to see.

The culminating activity will be for students to participate in a project that is of high interest to them. Students will be able to select from a list of suggestions or create their own. Some ideas would include make a brochure, draw a poster, create a book, or other visual to educate younger students about forces and motion (which is part of the K-5th grade curriculum).

Appendix One

North Carolina Essential Standards for Fifth Grade; Forces and Motion

- Forces and Motion
  - 5.P.1 - Understand force, motion and the relationship between them.
    - 5.P.1.1 - Explain how factors such as gravity, friction, and change in mass affect the motion of objects.
    - 5.P.1.2 - Infer the motion of objects in terms of how far they travel in a certain amount of time and the direction in which they travel.
    - 5.P.1.3 - Illustrate the motion of an object using a graph to show a change in position over a period of time.
    - 5.P.1.4 - Predict the effect of a given force or a change in mass on the motion of an object.

Comment [pt2]: This one page appendix will also be a stand alone document called: "Appendix ("Implementing Common Core Standards").

I don't know why it is to be in two places but that is what they said.

Appendices TKA02, Ramp Drawings

- The material we used was 16 gage Stainless Steel although regular sheet metal is fine.
- We then cut the parts out, deburred them, and then polished everything.
- We used wing nuts for easy assembly; however, a ¼”–20 nut and bolt tighten just fine with fingers for this job.
- Our track was BluTrack:

Qty 1, Item #1100, description 30.48 Meters or 100 feet of BluTrack PRO (ON-LINE ONLY)

http://www.shop.blutrackpro.com/product.sc?productId=7

Appendix TKA03, Ramp images

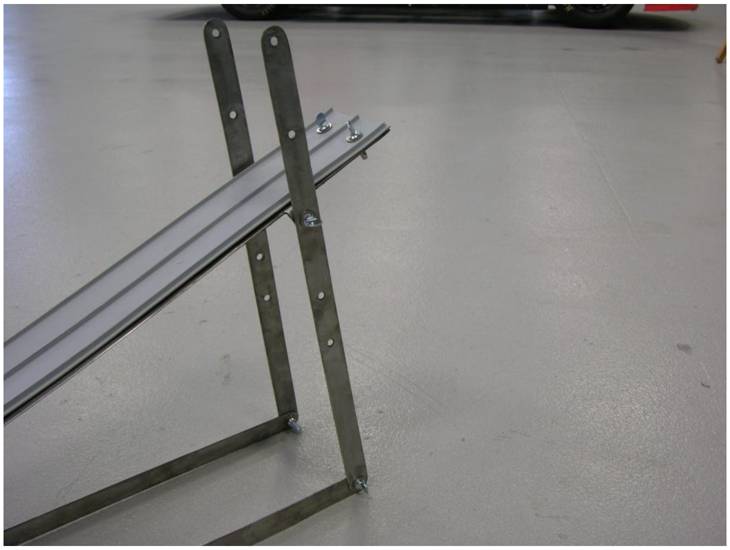

Figure 1. Adjustable height struts

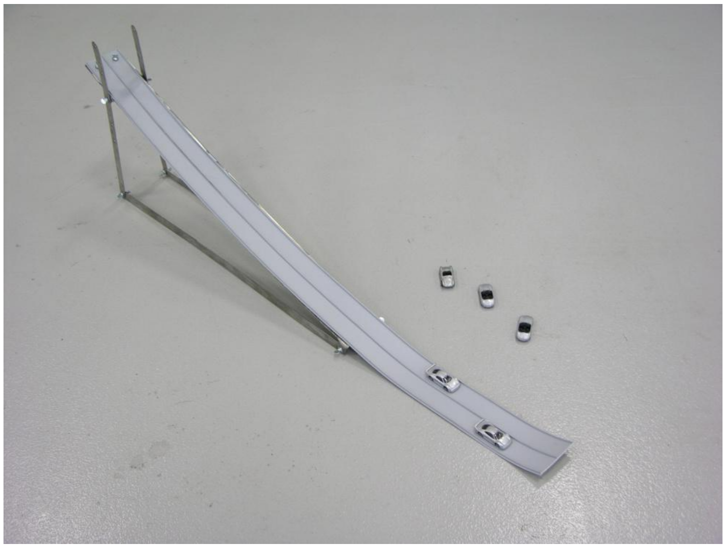

Figure 2. The ramp as used.

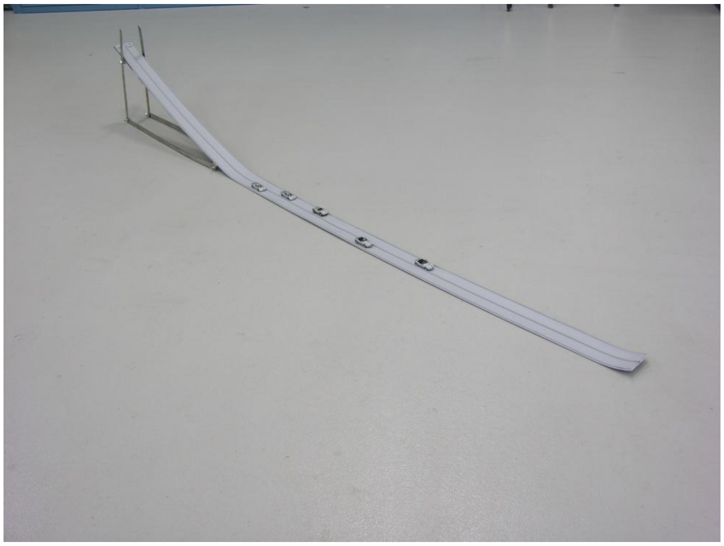

Figure 3. Ramp with 10' track.

Figure 4. Car with standard clay load set up for high drag.

Appendices Three: NASSCAR FUN Date Created: **November 17, 2012**

CATEGORY	**4**	**3**	**2**	**1**
Pit Stop	100 points Car stopped entirely inside the pit area.	75 points Some part of the car inside the pit area	50 points Car stopped within 2 cm of pit area	25 points car stopped within 4 cm of pit area
High on the Hill	150 points Car stops on the top of the hill on the first trial	100 points Car stops on the top of the hill on the second trial	50 points Car stops on the top of hill on the third trial	25 points Car stops on the top of the hill on fourth trial
Cliff Hanger	150 points Car comes to a stop within 3 cm of the cliff	100 points Car comes to a stop within 6 cm of the cliff	50 points Car comes to stop with 9 cm of cliff	-25 points :(Car goes over cliff!
~~**Demolition**~~ **Demolition** **Derby**	100 points Car can still roll after crashing into barrier at the end of the ramp	50 points Car can still roll after crashing into barrier at 50 mm	25 points Car can still roll after crashing into barrier at one meter	0 Points Car is disabled after crashing into barrier at one meter
Cruise Inn/Car Show	Points will be determined by number of student votes for each car			
Journal/Log - Content	100 points Journal provides a complete record of planning, construction, testing, modifications, reasons for modifications, and some reflection about the strategies used and the results.	Journal provides 75 points Journal provides a complete record of planning, construction, testing, modifications, and reasons for modifications.	50 points Journal provides quite a bit of detail about planning, construction, testing, modifications, and reasons for modifications.	Journal provides very little detail about several aspects of the planning, construction, and testing process.

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Background information on the author Diandra Leslie-Pelecky

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