Nature of Science and Nature of Math Analysis

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Abstract

This project involves analyzing the article *Driverless cars can change lanes more like humans do* by Massachusetts Institute of Technology with the Nature of Science and the Common Core Math Practices tenets. The overall goal of this assignment is to look at how an article posted in the media can have at least 3 tenets from both the NOS and CCMP. This is accomplished by looking at the article and reviewing both the Nature of Science and the Common Core Math Practices.

Nature of Science and Nature of Math Analysis

Math and science is found simultaneously in many aspects of life. As learners, it is important that we see that math and science is found in all parts of our lives, not just in a school setting. In this analysis, *Driverless cars can change lanes more like humans do* is going to be explained under the ideas of the Nature of Science and the Nature of Math.

Part A. Nature of Science

The NGSS provides teachers and students with a resource to apply science concepts to any real-world situation. As appendix H states "the goal of science education is to help students understand the nature of scientific knowledge" (NGSS, 2013). This is not just seen in the science classroom, but rather in everyday life. The next few paragraphs are going to analyze the article under the lens of the NGSS matrix.

Scientific Knowledge is Based on Empirical Evidence

Scientific Knowledge is based on Empirical Evidence is a category in the matrix that deals most with practices (NGSS, 2013). In the article, the Massachusetts Institute of Technology talks about how they are looking at a method to create an algorithm that allows self-driving cars to change lanes. The research that the team from MIT has conducted is looking at the cars direction and velocity using a logistic function and then multiplying this by the "Gaussian distribution skews" (Massachusetts Institute of Technology, 2018). The data that they are looking at is a "connections between evidence and explanations" (NGSS, 2013). From the distribution and the logistic function, they can find the cars buffer zone, which is the zone where there will be collision avoidance (Massachusetts Institute of Technology, 2018). The evidence that they have collected is that if "traffic is fast enough and dense enough, precomputed buffer zones may be too restrictive. An autonomous vehicle will fail to change lanes at all, whereas a human driver

would cheerfully zip around the roadway" (Massachusetts Institute of Technology, 2018). This has brought them to their current problem that they are trying to solve. They can create the algorithms, but how can they make sure that they are creating buffer zones that can be accessed by the car quickly and avoid collisions. They are accomplishing this by looking at trial runs, observations and patters, all which are empirical evidence.

Science is a Way of Knowing

In the NGSS matrix, the crosscutting concepts is the ideas that "science is both a body of knowledge and the processes and practices used to add to that body of knowledge" (NGSS, 2013). Car technology is a knowledge that we have had for many decades, but as the world changes and technology advances, we need to add to that body of knowledge. For MIT, that is exactly what they are doing as they create their algorithms for the autonomous car. "They begin with a so-called Gaussian distribution -- the familiar bell-curve probability distribution. That distribution represents the current position of the car, factoring in both its length and the uncertainty of its location estimation" (Massachusetts Institute of Technology, 2018). Then, they are looking at what happens when they put in the new algorithm in a simulation, including a test of up to 16 autonomous cars mixed in with other cars driven by humans. They are working with something that has never been done before by looking at way of manipulating math and science that we already know and understand. The MIT team is analyzing their process and algorithms to see how it worked in a trial, then make revisions, which allows them to continue to expand on their knowledge. They know about the distribution of cars on the road and how this works, but they are taking that information and applying it to this new problem they are facing.

Science is a Human Endeavor

Human Endeavor means that science does "affect everyday life" (NGSS,2013). MIT is working with a task that could change the world. When MIT has a working algorithm, they will be able to create cars that have different driving styles and be able to drive themselves. Pierson, from MIT, explains that "each car used a different risk threshold that produced a different driving style, allowing us to create conservative and aggressive drivers. Using the static, precomputed buffer zones would only allow for conservative driving, whereas our dynamic algorithm allows for a broader range of driving styles" (Massachusetts Institute of Technology, 2018). This algorithm will have technological advances that meet the demands and the influences of the world around us (NGSS, 2013). This is the creativity and imagination of some of the top scientist today coming together to create something that will be a significant technological advancement of the 21st century.

Part B. Nature of Math

The nature of math revolves around eight different mathematical practices. These mathematical practices give teachers and students a focus point for how the problems should be solved. When used regularly, these practices help teach students to be well-rounded mathematicians, as well as critical thinkers. All of the practices provide structures and processes that can be used in a math classroom and everyday life. In the following paragraphs, MIT's article will be explained though the Common Core Math Practices.

Make Sense of Problems and Persevere in Solving Them

In the world today, there is the new development of autonomous vehicles. The problem or motivation for the scientists at MIT is "what can we do with as little information as possible?" (Massachusetts Institute of Technology, 2018). The scientists have been trying to figure out how to make the autonomous car behave and drive like a human driver. The team is in the process of making sense of the problem. They are coming up with ways to solve this problem by using different methods and trying to solve this complex dilemma (2010). The team at MIT is doing exactly what Math Practice 1 is trying to say; how can they take what they already know and use it as an entry point for this problem of changing lanes. The team has some ideas and has made conjectures about their plans, but have not been totally successful yet. One way they have persevered through this problem is that they did not stop with the original buffer zone that made it so that the car was not changing lanes at all, but instead they tried other options to make it so the car was not too restrictive (Massachusetts Institute of Technology, 2018). They know what their optimal solution and even though they are not there yet, they are not going to give up until their goal has been reached.

Model with Mathematics

Modeling with mathematics by the CCMP is "applying the mathematics they know to solve problems arising in everyday life, society, and the workplace" (2010). This is exactly what the scientists are doing with these cars. They are using math that they already knew and are applying it to this new problem that they are facing. They are looking at a car that they know can self-drive in the perfect condition, as in with no human drivers on the road. Modeling with mathematics also takes into account analyzing and drawing conclusions. In the article, they analyzed the skewed distribution for the new buffer zone and were working on creating a few simple equations that will allow the cars systems to evaluate its driving as the road changes (Massachusetts Institute of Technology, 2018). Basically, this whole experiment is a large-scale model of what driving might look like in the future when cars can drive and operate by themselves.

Use Appropriate Tools Strategically

In the world of mathematics, it is critical to use the mathematical toolbox when a problem arises. In the case of the article, the scientists at MIT are using the appropriate tools. CCMP says using appropriate tools strategically means that students look at the available tools when solving a mathematical problem (2010). For the problem at hand, there are several components that go into how the car can switch lanes, the car needs to be able to avoid collisions by planning lane changes that have the vehicle stay out of the buffer zone of other vehicles (Massachusetts Institute of Technology, 2018). The team also wants the car to be able to model a whole range of drivers, because not every car on the road drives the same. The tools that they are using is a

"method of describing buffer zones, so that the collision- avoidance proof can be executed quickly" (Massachusetts Institute of Technology, 2018). The algorithm that was created to describe the buffer zone has become the main tool in trying to solve this problem. This buffer zone was originally created by knowing the vehicles direction and velocity, which is a mathematical tool that was already known (Massachusetts Institute of Technology, 2018). Tools allow for the task to become easier and provide a starting point for the end goal, a car that can drive and switch lanes like a human driver.

Conclusion

A self-driving car is what MIT believes to be the future and through their dedication to math and science, it could be right around the corner. This article is a great example of how a problem of changing lanes for an autonomous car can encompass so many principals of both the nature of science and math. It is important to remember that math and science impacts so much of the 21st century world that we live in, so students should know how to handle and utilize the practices that will make them stronger math and science thinkers.

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